FINAL FEASIBILITY STUDY REPORT
OLD ROOSEVELT FIELD
CONTAMINATED GROUNDWATER SITE
GARDEN CITY, NEW YORK

Work Assignment No.: 146-RICO-02PE
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Acronyms

ARARs	applicable or relevant and appropriate requirements
AS	air sparging
bgs	below ground surface
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
CO_2	carbon dioxide
COPCs	chemicals of potential concern
CTE	central tendency exposure
CVOCs	chlorinated volatile organic compounds
1,1-DCE	1,1-dichloroethene
DHC	*Dehalococcoides spp.*
DNAPL	dense non-aqueous phase liquids
EAB	Enhanced Anaerobic Bioremediation
EPA	U.S. Environmental Protection Agency
FRTR	Federal Remediation Technology Roundtable
ft/d	feet per day
GAC	granular activated carbon
GCW	groundwater circulation wells
gpd/ft	gallon per day per foot
gpm	gallons per minute
GRAs	General Response Actions
HHRA	Human Health Risk Assessment
HI	hazard index
ISCO	In-Situ Chemical Oxidation
JMA	John Milner Associates, Inc.
K_d	adsorption coefficient
K_{oc}	organic carbon partition coefficients
lb/hr	lb per hour
lbs/day	pounds per day
LIRR	Long Island Railroad
MCL	Maximum Contaminant Level
MCLGs	maximum contaminant level goals
mg/L	milligrams per liter
MGD	million gallon per day
MNA	monitored natural attenuation
msl	mean sea level
MTBE	methyl tert-butyl ether
NCDH	Nassau County Department of Health
NCDPW	Nassau County Department of Public works
NCP	National Contingency Plan
NYSDEC	New York State Department of Conservation
O&M	operation and maintenance
ORP	oxidation reduction potential
PCE	tetrachloroethylene
ppb	parts per billion

ppbv	parts per billion by volume
PPE	personal protective equipment
PRBs	Permeable Reactive Barriers
PRGs	Preliminary Remediation Goals
OSHA	Occupational Safety and Health Administration
RAC	Response Action Contract
RAGS	Risk Assessment Guidance for Superfund
RAOs	Remedial action objectives
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/ Feasibility Study
RME	reasonable maximum exposure
site	Old Roosevelt Field Contaminated Groundwater Superfund Site
SPDES	State Pollution Discharge Elimination System
SVE	Soil Vapor Extraction
SVP	screening vertical profile boring
TBC	To Be Considered
T/M/V	toxicity/mobility/volume
TCA	1,1,1,-trichloroethane
TCE	trichloroethene
UCL	upper confidence limit
$\mu g/L$	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
U.S.	United States
USGS	United States Geological Survey
UV	ultraviolet
VC	vinyl chloride
VFAs	volatile fatty acids
VOCs	volatile organic compounds

Executive Summary

Executive Summary

Introduction

CDM Federal Programs Corporation (CDM) received Work Assignment 146-RICO-02PE under the Response Action Contract (RAC) to perform a remedial investigation/feasibility study (RI/FS) and a human health risk assessment (HHRA) at the Old Roosevelt Field Contaminated Groundwater Superfund Site (site), located in Garden City, Nassau County, New York, for the United States Environmental Protection Agency (EPA), Region 2. The purpose of this work assignment is to investigate the overall nature and extent of contamination at the site and to develop a range of remedial alternatives to remediate the site. This FS report was prepared in accordance with Task 12 of CDM's Final Work Plan, dated December 10, 2004.

Site Description

The Roosevelt site is an area of groundwater contamination within the Village of Garden City, in central Nassau County, New York. The site is located on the eastern side of Clinton Road, south of the intersection with Old Country Road. The Roosevelt site includes a thin strip of open space along Clinton Road (known as Hazelhurst Park), a large retail shopping mall with a number of restaurants, and a movie theater. Several office buildings (including Garden City Plaza) which share parking space with the shopping mall are situated around its perimeter. Two Village of Garden City public supply wells (GWP-10 and GWP-11) are located east of Clinton Road on the southwestern corner of the site. Two recharge basins are directly east and south of the public supply wells. The eastern basin is known as Pembrook and is on property owned by the mall. The basin situated to the south is Nassau County Storm Water Basin number 124.

Site History

The Roosevelt site was used for aviation activities from 1911 to 1951. The United States (U.S.) military began using the Hempstead Plains field prior to World War I to train Army and Navy officers and as a training center for military pilots. In 1918, the Army changed the name of the airfield to Roosevelt Field.

After World War I, the U.S. Air Service authorized aviation-related companies to operate from Roosevelt Field, but maintained control until July 1, 1920, at which time the Government relinquished control of the field for commercial aviation uses.

During World War II, Roosevelt Field was again used by both the Army and Navy. The Army used the field to provide airplane and engine mechanics training to Army personnel. As of March 1942, there were 6 steel/concrete hangars, 14 wooden hangars, and several other buildings at Roosevelt Field, which were used to receive, refuel, crate, and ship Army aircraft. In November 1942, the Navy Bureau of Aeronautics established a modification center at Roosevelt Field to install British equipment into U.S. aircraft for the British Royal Navy. The Navy was responsible for aircraft repair and maintenance, equipment installation, preparation and flight delivery of lend-lease aircraft, and metal work required for the installation of British modifications. The facility also performed salvage work of crashed Royal Navy planes. The Navy vacated all but six hangars shortly after the war ended. In August 1946, Roosevelt Field again operated as a commercial airport until it closed in May 1951.

Soon after the airfield closed, construction began at Roosevelt Field and further development was planned. The large Roosevelt Field Shopping Center was constructed at the site and opened in 1957. Three of the old Navy hangars remained standing until some time after June 1971, with various occupants, including a moving/storage firm, discotheque, amusement center, and bus garage.

Garden City installed supply wells GWP-10 and GWP-11 in 1952, at what had been the southwest corner of the airfield. These two wells were put into service in 1953. Over the subsequent years, several other supply wells and cooling water wells were installed and operated at the former Roosevelt Field. In the late 1970s and early 1980s, investigations conducted by Nassau County found the contaminants trichloroethene (TCE) and tetrachloroethene (PCE) in supply wells GWP-10 and GWP-11. High levels of contamination also were found in cooling water wells at the site. The site was listed on the National Priority List (NPL) on May 11, 2000.

Previous Investigations

After PCE and TCE were detected in supply wells GWP-10 and GWP-11 in the late 1970s and early 1980s, several investigations were performed at the site or near the site by the Nassau County Department of Health (NCDH), Nassau County Department of Public Works (NCDPW), United States Geological Survey (USGS), and New York State Department of Environmental Conservation (NYSDEC) (CDM 2007). These investigations confirmed the groundwater contamination at the site by chlorinated volatile organic compounds (VOCs) emanating from the Roosevelt Field area, but no soil contamination was found at the site.

From March 1982 through September 1984, the USGS, NCDH, and NCDPW completed a comprehensive study to evaluate the occurrence and movement of VOC contamination in the groundwater at Roosevelt Field. The USGS report presenting the findings indicated that the original plume was probably within the area near the site of aircraft-maintenance hangars (slightly north of the current 100 Ring Road, and in the vicinity of 100 Garden City Plaza, 200 Garden City Plaza, and 300 Garden City Plaza). The original plume has moved horizontally south and downgradient in the Upper Glacial aquifer and downward into the Magothy aquifer.

The report identified the contaminant plume in the Upper Glacial aquifer with the highest total VOC concentrations detected at 890 micrograms per liter (µg/L) from Upper Glacial aquifer observation well N-9973, west of 200 Garden City Plaza. The report also identified the contaminant plume in the Magothy aquifer. The highest total VOC concentrations were detected at cooling water well N-8050 at 41,000 µg/L. Two other cooling water wells also had high total VOCs concentrations. Cooling water well N-9311, at the northwest corner of 100 Garden City Plaza had total VOCs of 3,500 µg/L; and cooling water well N-9310, west of 300 Garden City Plaza had total

VOCs of 1,500 μg/L in 1984. Garden City supply wells GWP-10 and GWP-11 had total VOC concentrations less than 30 μg/L during the investigation. The report indicated that the water withdrawals for public supply and cooling usage from the Magothy aquifer, especially during the hot summer months when all 11 Magothy wells were pumping, significantly increased the vertical movement of groundwater, and, therefore, increased the downward transport of contaminants in the Magothy aquifer.

Site Investigations

From June 2005 to December 2006, CDM performed the RI at the site. The RI included a hydrogeological investigation, a source area soil gas investigation, an ecological investigation, and a Stage 1 culture resource survey.

Hydrogeological Investigation

- Conducted a geophysical utility survey to locate underground utilities at drilling locations
- Collected discrete-depth groundwater screening samples at 20-foot intervals for 24-hour turnaround VOC analysis to assist in selection of multi-port well screen intervals at 8 locations
- Conducted borehole natural gamma logging in eight multi-port well borings
- Installed and developed 4-inch diameter outer screen and casing assemblies to support the multi-port monitoring well equipment
- Installed Westbay multi-port well equipment at eight locations
- Collected two rounds of hydrostatic pressure and synoptic water level measurements
- Re-developed nine existing monitoring wells
- Collected two rounds of groundwater samples from eight multi-port monitoring wells, nine existing monitoring wells, and two supply wells

Source Area Soil Gas Investigation

- Conducted geophysical utility survey to locate underground utilities
- Installed temporary soil gas points and conducted soil gas screening using Geoprobe soil gas sampling apparatus and ppbRAE in the source area at 158 locations at two depths: 15 feet bgs and 35 feet bgs
- Collected 36 soil gas samples using canisters adjacent to three office buildings and along Clinton Road (Hazelhurst Park), for laboratory analysis using method TO-15

Physical Characteristics of the Study Area

The site is located within the Atlantic Coastal Plain of New York. The topography of the central portion of Nassau County is characterized by a gently southward-sloping glacial outwash plain. The site is flat to gently undulating with slopes from approximately 100 feet above mean sea level (msl) at the northern edge (along Old Country Road) down to approximately 70 feet above msl about 4,000 feet south-southwest of Roosevelt Field, along Clinton Road.

In the vicinity of the Roosevelt site the sedimentary units thicken from about 800 feet at the northern edge of the Town of Hempstead to approximately 1,500 feet thick beneath the barrier islands. The Upper Glacial deposits and the Magothy Formation are the geologic units of interest for the site. The Magothy Formation consists of fine to medium quartz sand, interbedded clayey sand with silt, clay, and gravel interbeds or lenses. Interbedded clay is more common toward the top of the formation. The Upper Glacial deposits are composed mainly of stratified beds of fine to coarse-grained sand and gravel; thin beds of silt and clay are interbedded with coarse-grained material

The Upper Glacial and Magothy aquifer is unconfined and forms a single aquifer unit, although with different properties. In the Old Roosevelt Field area, the depth to water ranges from 20 to 50 feet below the ground surface (bgs), the saturated thickness of the Upper Glacial aquifer ranges from 20 to 40 feet; the thickness of the Magothy aquifer is about 500 feet. They are the most productive and heavily utilized groundwater resource on Long Island. Average transmissivities are 240,000 gallon per day per foot (gpd/ft) for the Magothy aquifer and 200,000 gpd/ft in the Upper Glacial aquifer. Average hydraulic conductivities are 228 feet per day (ft/d) in the Upper Glacial and 56 ft/d in the Magothy (Krulikas 1987b).

During the RI, the depth to the water table at the site was measured between 27 and 37.6 feet bgs. The general horizontal groundwater flow trend is to the south. Based on Round 1 data of the RI for the shallow aquifer, the groundwater flow gradient is 0.00156. Given this flow gradient, a porosity of 0.15, and the conductivity for the Magothy aquifer (approximately 56 ft/d), the flow rate is estimated to be 0.6 ft/d.

Water level elevation data from the multi-port wells installed during the RI showed that the vertical groundwater flow is downward. The four multi-port wells in the mall area have similar vertical gradients, with the differences between water levels in the shallow and deep ports within each well ranging from 1.8 to 2.9 feet. Further to the south, the vertical gradients become larger.

No naturally-occurring surface water bodies are present in the vicinity of the Roosevelt site. Almost the entire site area is paved or is occupied by buildings. Any runoff is routed into storm water collection systems and commonly is discharged directly to either dry wells or recharge/retention basins. The Pembrook recharge basin and two Nassau County recharge basins are man-made water table recharge basins located at or near the site. Currently the Pembrook recharge basin appears to receive surface water runoff during storm events. The Nassau County basins receive storm runoff from the municipal storm water collection system.

Nature and Extent of Contamination

To focus the evaluation of the nature and extent of groundwater contamination, the site-related contaminants were identified during the RI. They are PCE, TCE, cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE), and carbon tetrachloride. Concentrations of cis-1,2-DCE, 1,1-DCE, and carbon tetrachloride were only detected at low levels. The nature and extent of groundwater and soil gas contamination is summarized below.

Groundwater

Groundwater screening criteria were developed based on EPA's National Primary Drinking Water Maximum Contaminant Levels (MCLs), New York State Standards and Guidance Values for Class GA groundwater (Human Water Source), and NYSDOH drinking water standards. The criteria selected for the site-related contaminants were all at 5 µg/L.

During the RI, site-related contaminant concentrations in the Upper Glacial aquifer were non-detect or lower than the groundwater screening criteria. Therefore, the discussion below will focus on the contamination in the Magothy aquifer.

Two rounds of VOC samples were collected from the eight multi-port monitoring wells and the 10 existing wells. The highest levels of PCE and TCE (350 and 280 µg/L, respectively) are concentrated at SVP/GWM-4 at approximately 250 to 310 feet deep. It should be noted that the SVP-4 location was selected for monitoring because a distilling well/drain field was operated in the area during the 1980s, to dispose of cooling water contaminated with the site-related VOCs. The next highest levels occur downgradient (to the south) of SVP/GWM-4 in existing well GWX-10019, at a slightly shallower depth at approximately 223 to 228 feet bgs, and at the two supply wells GWP-10 and GWP-11, at approximately 370 to 417 feet deep. Multi-port well SVP/GWM-7, located southwest of the supply wells, showed 20 µg/L of TCE and 7.7 µg/L of PCE at approximately 310 to 315 feet. Further downgradient, monitoring well SVP/GWM-8, installed during the RI, showed 34 µg/L of PCE at approximately 100 to 105 feet and 57 µg/L of PCE at the same depth from round 1 and round 2 sampling, respectively. TCE was detected at levels below the MCL in both rounds. Monitoring well SVP/GWM-6 showed a detection of 8.2 µg/L of TCE at 245 to 250 feet in round 1 and 2.3 µg/L in round 2 at the same depth. PCE was detected in several depths during both sampling rounds, but at levels below the MCL.

GWP-10 and GWP-11 each have a capacity to pump approximately one million gallons per day (mgd) of groundwater from the Magothy aquifer. Groundwater flow and contaminant movement is downward and south from the mall area to the Garden City supply wells. Contamination was observed south (downgradient) of the Garden City supply wells, as observed in the wells sampled.

Further downgradient of the supply wells, PCE and TCE contaminant levels in the most downgradient multi-port well (SVP/GWM-8) are seen at shallower depths than at the plume core in the mall area. Other sources of VOC contamination in the area south of the site may have contributed contamination.

The Village of Hempstead Water Supply Wellfield approximately one block south (downgradient) of multi-port monitoring wells SVP-6 and SVP-8, has been contaminated with VOCs since 1980s. Two of the wells in the Village of Hempstead Wellfield showed detections of 10.1 µg/L of TCE and 9.2 µg/L early this year through their routine monitoring. The source of this contamination is currently unknown since several potential sources are located in the vicinity of the Hempstead Wellfield.

Soil Gas
During the RI, PCE and TCE were detected in a few soil gas samples. EPA recently collected additional soil vapor samples at six commercial buildings in the mall area and soil samples at locations with elevated soil gas readings. The findings can be found in separate reports in the administrative record.

Contaminant Fate and Transport

The fate of a contaminant in the environment is determined by its physical and chemical properties, the geology it is released into, groundwater velocity, the geochemical conditions in the aquifer, the rate of degradation, and the adsorption coefficient (K_d). All site-related contaminants have low K_d values, which means that they have low adsorption capacity. Site groundwater has very low organic carbon; therefore, the retardation factors for the contaminants are low. Site-related contaminants are mobile and are expected to move with the groundwater, although at a relatively slower rate.

The primary and effective degradation pathway for PCE and TCE in the subsurface is via anaerobic dechlorination processes, in which PCE would be degraded to TCE, then cis-1,2-DCE and trans-1,2-DCE, then vinyl chloride (VC), and, finally, ethene. At this site, natural attenuation via biodegradation appears to be limited due to the aerobic conditions found in the aquifer, which are not suitable for anaerobic dechlorination. VC has never been detected in site samples. The natural attenuation processes of dilution and dispersion would be expected to result in a gradual reduction in contaminant levels.

The large scale pumping by cooling water wells and drinking water wells at the site has altered the natural groundwater flow and enhanced the downward movement of contaminants. The contaminant concentrations in the aquifer (as observed in N-8050 and SVP-2) as well as in the supply wells (GWP-10 and GWP-11) have significantly decreased from their highest historical values.

Human Health Risk Assessment

In the Human Health Risk Assessment (HHRA), contaminants in groundwater at the site were evaluated for potential health threats to future site workers and future residents.

The estimated carcinogenic risks for future site workers and future residents were slightly above the EPA's target range of 1×10^{-6} to 1×10^{-4}; the estimated non-carcinogen risks for future site workers and future residents were greater than 1, indicating potential for non-cancer hazards. PCE and TCE in groundwater contributed to most of the risk.

Screening Level Ecological Risk Assessment

A Screening Level Ecological Risk Assessment was not conducted. VOCs in the groundwater are the primary contaminants, and groundwater is the primary medium of concern at the site. Given that groundwater does not discharge to a surface water body, which prevents exposure to any potential ecological receptor at the site, a conclusion can be reached that there are no completed pathways present at the site for ecological receptors. In addition, the RI investigation concluded that the source areas are no longer present at the site, which prevents any potential exposure to contaminated soil for ecological receptors. Based on this information, there is adequate information to conclude that ecological risks are negligible and therefore there is no need for remediation on the basis of ecological risk.

Remedial Action Objectives and Preliminary Remediation Goals

The contaminants of concern for this site are PCE, TCE, cis-1,2-DCE, and 1,1-DCE. Carbon tetrachloride was identified as site-related contaminant in the RI report. However, it was not detected at concentrations above the screening criteria. Therefore, it was not considered in this FS. For this site the preliminary remediation goals (PRGs) are the groundwater MCLs. The remedial action objectives (RAOs) for groundwater are identified as follows:

- Prevent or minimize potential, current, and future human exposures including inhalation, ingestion and dermal contact with VOC-contaminated groundwater that exceeds the MCLs
- Minimize the potential for off-site migration of groundwater with VOC contaminant concentrations greater than MCLs
- Restore groundwater to beneficial use levels within a reasonable time frame, as specified in the National Contingency Plan (NCP)
- Mitigate site-related vapor migrating into the commercial buildings

The MCLs were selected based on federal or state promulgated regulations and are the same for PCE, TCE, cis-1,2-DCE, and 1,1-DCE (5 µg/L). The MCLs were then used as a benchmark in technology screening, remedial action alternative development, and detailed evaluation of alternatives in this FS report. Remedial technologies were identified and screened using effectiveness, implementability, and cost screening criteria, as required by EPA guidance. The retained remedial technologies were assembled into the following remedial action alternatives.

Remedial Action Alternatives for Groundwater

<u>Alternative 1 - No Action</u>

The No Action alternative is required by the NCP to be carried through the evaluation process, as it serves as a baseline for comparison with other site remedial action alternatives. Under this alternative, no action would be taken to remediate the contaminated groundwater at the site. This alternative would not involve any institutional controls or monitoring of groundwater. This alternative would not reduce the exposure of receptors to site contaminants. There are no capital or operation and maintenance costs associated with this alternative.

Alternative 2 - Monitoring

Under this alternative, the future operation of the two supply wells GWP-10 and GWP-11 is assumed to be at their current pumping rates (similar to 2001 to 2005). Long-term monitoring would be implemented to evaluate the migration and changes in the contaminant plume over time to ensure attainment of the MCLs. Institutional controls would restrict any future use of the site to commercial or light industrial, thereby limiting human exposure to contaminated groundwater. Soil vapor sampling would be conducted in six commercial buildings during the winter heating season and vapor mitigation would be implemented, as necessary.

The preliminary groundwater model indicates it would take 46 years for the contaminant concentrations in the plume to decrease below the MCLs.

The total present worth with discounting is $2.29 million. Capital cost is $0.30 million and annual long-term groundwater monitoring is $0.15 million for the first 25 years and $0.11 million starting at year 25. Since the groundwater plume decreases in size, the monitoring effort is reduced in year 25.

Alternative 3 - Groundwater Extraction and Ex-situ Treatment (Pump and Treat)

The pump and treat alternative would include evaluation of the current condition of the two air strippers at supply wells GWP-10 and GWP-11 and upgrade or replacement, as necessary. Alternative 3 would also include a pre-design investigation and additional groundwater modeling. A groundwater remediation extraction well would be installed downgradient from SVP-4, to capture the portion of the contaminant plume with high PCE and TCE concentrations without impacting the pumping capacity of supply wells GWP-10 and GWP-11. As the preliminary groundwater model indicated, the new extraction well would be operated for 10 years. It would take an additional 25 years (35 years total) for the contaminant concentrations in the plume to decrease to below the PRGs. Alternative 3 would include institutional controls, long-term monitoring, and vapor sampling at six commercial buildings similar to Alternative 2.

The total present worth cost with discounting for this alternative is approximately $13.16 million. Capital cost associated with this alternative is $6.24 million; the annual O&M cost, including O&M for the pump and treat system and annual monitoring sampling, is $0.85 million for the first 25 years and $0.79 million beginning in year 25. Since the groundwater plume decreases in size, the monitoring effort is reduced in year 25.

Contingency Plan

If for any reason supply wells GWP-10 and GWP-11 need to be shut down or experience a significant reduction of pumping rates, a contingency plan would be implemented to prevent downgradient migration of contaminants. The Village is requested to provide at least two-years advance notice to EPA, so the contingency plan could be implemented in a timely manner, including design and installation of the extraction well and construction of the treatment system. As the preliminary groundwater model indicated, the contingency plan would include the installation of a new extraction well in the vicinity of supply wells GWP-10 and GWP-11, two injection wells in an upgradient direction, and an ex-situ treatment system. The contingency extraction well would be designed to capture the entire contaminant plume.

The estimated capital cost is $5.66 million and the estimated O&M cost for the contingency pump and treat system is $0.68 million.

Comparative Analysis of Alternatives

Overall Protection of Human Health and the Environment

Alternative 1 would not include any monitoring or remedial measures, and as such, would not be protective of human health and the environment. Alternatives 2 would also not be protective of human health and the environment since it only includes monitoring of the groundwater plume and vapor sampling. Alternative 2 provides institutional controls which would result in minimal protection of human health. Alternative 3 would provide overall protection of human health and the environment through implementation of a remedial pump and treat system to extract and treat the groundwater contamination and vapor intrusion mitigation, if deemed necessary.

Compliance with ARARs

Alternatives 1 and 2 would not comply with chemical-specific ARARs because no groundwater treatment would be undertaken. Alternative 2 would comply with action-specific ARARs such as health and safety requirements. Alternative 3 would comply with chemical-specific ARARs through active removal and treatment of groundwater contamination. Alternative 3 would also comply with location- and action-specific ARARs.

Long-Term Effectiveness and Permanence

Alternative 1 would not provide long-term effectiveness and permanence since no action is taken to remove contamination from the groundwater. Alternative 2 would provide a small degree of long-term effectiveness and permanence through institutional controls. Alternative 3 would provide long-term effectiveness and permanence by extracting contaminated groundwater from the aquifer and treating it to remove the contaminants. Alternative 3 would also provide for vapor intrusion mitigation in the commercial buildings, if vapor sampling indicates mitigation is necessary.

Reduction of T/M/V Through Treatment

Alternatives 1 and 2 would not reduce T/M/V through treatment since no treatment would be implemented. Alternative 3 would reduce the mobility and volume of the contaminant plume through groundwater extraction and reduce the toxicity of water through ex-situ treatment using air strippers. Alternative 3 would prevent the contaminant plume with concentrations above the MCLs from migrating downgradient. Alternative 3 would also mitigate vapor intrusion in the commercial buildings, if sampling indicates mitigation is necessary.

Short-Term Effectiveness

Alternative 1 would not have any short-term impact. Alternative 2 would have minimal short-term impact to the community and the environment during annual groundwater sampling. Alternative 3 would have some impact to the community due to the drilling of wells and the construction of the groundwater extraction well(s) and treatment system, but the duration would be short and the disturbance would be minimal.

Implementability

All three alternatives are implementable. Alternative 1 would be the easiest to implement, since it involves no action. Alternative 2 would be the next easiest to implement, since it only involves annual sampling of monitoring wells and would not have any ground intrusion activities. Alternative 3 would also be easy to implement. Access for installation of extraction well(s) and construction of a treatment facility would be required and various contractors would need to be procured. Construction activities could be conducted using standard equipment and procedures.

Cost

Alternative 1 would not involve any costs. Alternative 2 would have the lowest costs since it only includes annual sampling of monitoring wells and one round of vapor intrusion sampling of the commercial buildings. Alternative 3 would have medium capital and O&M costs. The costs associated with Alternative 3 primarily reflect the installation and operation of a groundwater extraction and treatment system and vapor intrusion sampling in the commercial buildings.

1

Section One

Section 1
Introduction

CDM Federal Programs Corporation (CDM) received Work Assignment 146-RICO-02PE under the Response Action Contract (RAC) to perform a remedial investigation/feasibility study (RI/FS) and a human health risk assessment (HHRA) at the Old Roosevelt Field Contaminated Groundwater Area Superfund Site (site), located in Garden City, Nassau County, New York (Figure 1-1), for the United States Environmental Protection Agency (EPA), Region 2. The purpose of this work assignment is to investigate the overall nature and extent of contamination at the site and to develop a range of remedial alternatives to remediate the site. This FS report was prepared in accordance with Task 12 of CDM's Final Work Plan, dated December 10, 2004 (CDM 2004).

The primary objective of the RI/FS is to gather sufficient information about the site-related groundwater contamination to support an informed risk management decision regarding the remedy that is the most appropriate for the site. The RI serves as the mechanism for collecting the data to characterize the extent of groundwater contamination, and assessing risk to human health and the environment. The FS serves as the mechanism for developing, screening, and evaluating remedial alternatives.

1.1 Purpose and Organization of the Report

The purpose of the FS is to identify, develop, screen, and evaluate a range of remedial alternatives for the contaminated media and to provide the regulatory agencies with sufficient data to select a feasible and cost-effective remedial alternative that protects public health and the environment from potential risks at the site.

The report was prepared in accordance with EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)* (EPA 1988). This FS report is comprised of six sections as described below.

- **Section 1 - Introduction** provides a summary of site background information including the site description, site history, description of physical characteristics of the site, RI sampling activities, and the nature and extent of contamination.

- **Section 2 - Development of Remedial Action Objectives and Technology Screening** develops a list of remedial action objectives by considering the characterization of contaminants, the risk assessments, and compliance with site-specific applicable or relevant and appropriate requirements (ARARs); documents the quantities of contaminated media; identifies general response actions; and identifies and screens remedial technologies and process options.

- **Section 3 - Development of Remedial Action Alternatives** presents the remedial alternatives developed by combining the feasible technologies and process options.

- **Section 4 - Detailed Description of Remedial Action Alternatives** provides preliminary design assumptions on the alternatives that were retained. This information is used to develop the cost estimates for each alternative in Section 5.

- **Section 5 - Detailed Analysis of Remedial Action Alternatives** provides the detailed analysis of each alternative with respect to the following nine criteria: overall protection of human health and the environment; compliance with the ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; state acceptance; and community acceptance. An overall comparison between the various remedial alternatives is also examined in this section.

- **Section 6 - References** provides a list of references used to prepare the FS.

1.2 Site Description

The Roosevelt site is an area of groundwater contamination within the Village of Garden City, in central Nassau County, New York. The site is located on the eastern side of Clinton Road south of the intersection with Old Country Road. The Roosevelt site includes a thin strip of open space along Clinton Road (known as Hazelhurst Park), a large retail shopping mall with a number of restaurants, and a movie theater. Several office buildings (including Garden City Plaza) share parking space with the shopping mall. Two municipal supply wells (GWP-10 and GWP-11) are located in the vicinity. Two recharge basins are directly east and south of the mall area. The eastern basin, Pembrook, is on property owned by the mall. The basin to the south is Nassau County Storm Water Basin number 124 (Figure 1-2).

1.3 Site History

The Roosevelt site was used for aviation activities from 1911 to 1951. The United States (U.S.) military began using the Hempstead Plains field prior to World War I to train U.S. Army and U.S. Navy officers and as a training center for military pilots. In 1918, the Army changed the name of the airfield to Roosevelt Field.

After World War I, the U.S. Air Service authorized aviation-related companies to operate from Roosevelt Field, but maintained control until July 1, 1920, at which time the U.S. Government relinquished control of the field for commercial aviation uses.

During World War II, Roosevelt Field was again used by both the Army and Navy. The Army used the field to provide airplane and engine mechanics training to Army personnel. As of March 1942, there were 6 steel/concrete hangars, 14 wooden hangars, and several other buildings at Roosevelt Field, which were used to receive, refuel, crate, and ship Army aircraft. In November 1942, the Navy Bureau of Aeronautics established a modification center at Roosevelt Field to install British equipment into U.S. aircraft for the British Royal Navy. The Navy was responsible for aircraft repair and maintenance, equipment installation, preparation and flight delivery of lend-lease aircraft, and metal work required for the installation of British modifications. The facility also performed salvage work of crashed Royal Navy planes. The Navy vacated all but six hangars shortly after the war ended. In August 1946, Roosevelt Field again operated as a commercial airport until it closed in May 1951.

Soon after the airfield closed, construction began at Roosevelt Field and further development was planned. The large Roosevelt Field Shopping Center was constructed at the site and opened in 1957. Three of the old Navy hangars remained standing until some time after June 1971, with various occupants, including a moving/storage firm, discotheque, amusement center, and bus garage.

Garden City installed municipal supply wells GWP-10 and GWP-11 in 1952, at what had been the southwest corner of the airfield. These two wells were put into service in 1953. Over the subsequent years, several supply wells and cooling water wells were installed and operated at the former Roosevelt Field. In 1984, during the groundwater contamination investigation conducted by the United States Geological Survey (USGS), four supply wells and seven cooling-water wells were pumping water from the Magothy aquifer, the main water resource for Long Island (Eckhardt 1989). Some of these wells were abandoned, and some were shut down, due to the detection of elevated concentrations of chlorinated volatile organic compounds (CVOCs) in most of these wells. The two Garden City supply wells GWP-10 and GWP-11 have been kept in service. In 1987, air-strippers were installed to remove the contaminants before discharging the treated water into the Village water system. The site was listed on the National Priority List (NPL) on May 11, 2000.

1.4 Site Investigation

1.4.1 Previous Investigations

In the late 1970s and early 1980s, tetrachloroethene (PCE) and trichloroethene (TCE) were detected in supply wells GWP-10 and GWP-11 (Table 1-1). Subsequently, several investigations have been performed at the site or near the site by the Nassau County Department of Health (NCDH), Nassau County Department of Public Works (NCDPW), USGS, and New York State Department of Environmental Conservation (NYSDEC) (CDM 2006). These investigations confirmed the groundwater contamination at the site by CVOCs emanating from the Roosevelt Field area, but no soil contamination was found at the site. Investigations conducted prior to the RI are described briefly below.

<u>Roosevelt Field Groundwater Contamination Study - Nassau County Department of Health (NCDH), Geraghty & Miller, 1986</u>. This study indicated that pumping from the Magothy aquifer by non-contact cooling water wells and discharge of the spent cooling water to Pembroke Basin significantly affected seasonal water table elevations.

Vertical flow was occurring between the water table aquifer and the underlying principal municipal water aquifer at Roosevelt Field. A cone of depression around the pumping wells appeared to have a strong influence on the movement of contaminants. The highest contamination detected in deep wells at Roosevelt Field was found in cooling water well N-8050, 40,890 parts per billion (ppb) total VOCs, located near the northwest corner of the shopping center.

Environmental Assessment Report - Subsurface Investigation for Soil Contamination for the Proposed Clinton Road/Stewart Avenue Bypass at Roosevelt Field - Nassau County Department of Public Works (NCDPW). Eighteen shallow and 11 deep borings were installed in the western section of the site to provide an assessment of the potential impact from excavation of contaminated soil during construction of a new road. None of the samples collected from the 29 soil borings had detections of the contaminants of concern (CDM 1987).

USGS Water Resources Investigation 86-4333, 1989. (Eckhardt 1989) From March 1982 through September 1984, the USGS, NCDH, and NCDPW completed a study to evaluate the occurrence and movement of VOCs in the groundwater at Roosevelt Field. Wells sampled included 52 monitoring wells, 28 public supply wells and 25 cooling water wells in a 10 square mile area (see Plate 1 and Figure 5, Eckhardt 1989). Seven additional shallow and two deep Magothy Aquifer wells were installed. During this investigation period, four public supply wells and seven cooling water wells pumped water from the Magothy aquifer at Roosevelt Field. The four public supply wells operated all year, pumpage exceeding 4 million gallon per day (MGD) during hot and dry weather. The cooling water wells operated seasonally during warm weather. The combined pumpage from cooling water wells in 1984 was about 4 MGD. The contaminated cooling water were discharged to Pembrook recharge basin first, extra was discharged to Nassau County stormwater basin 124, located west of Pembrook recharge basin.

The USGS report indicated that the original plume was probably within the area near the site of aircraft-maintenance hangars (slightly north of the current 100 Ring Road, and in the vicinity of 100 Garden City Plaza, 200 Garden City Plaza, and 300 Garden City Plaza). The original plume has moved horizontally south-southwest downgradient in the Upper Glacial aquifer and downward into the Magothy aquifer. The report identified the contaminant plume in the Upper Glacial aquifer (see Figure 1-3) and showed that the cooling water discharge at the drain field and recharge basin had obscured this plume. The highest total VOC concentrations detected was 890 micrograms per liter (μg/L) from Upper Glacial aquifer observation well 9973 west of 200 Garden City Plaza.

The report also identified the contaminant plume in the Magothy aquifer (Figure 1-3). The highest total VOC concentrations were detected at cooling water well N-8050 at 41,000 μg/L. Two other cooling water wells also had high total VOC concentrations. Cooling water well N-9311, at the northwest corner of 100 Garden City Plaza had total VOCs of 3,500 μg/L; and cooling water well N-9310, west of 300 Garden City Plaza had total VOCs of 1,500 μg/L in 1984. Garden City supply wells GWP-10 and GWP-11 had total VOC concentrations less than 30 µg/L. The report indicated that the withdrawals for public supply and cooling water from the Magothy aquifer, especially during the hot summer months when all 11 Magothy wells were pumping, had significantly increased the vertical movement of groundwater, and, therefore, increased the downward transport of contaminants in the Magothy aquifer.

Field Report Summary, New York Superfund Standby Contract, Garden City Schools Field Investigation. In 1993, NYSDEC performed soil vapor sampling at Stewart School located approximately 3,000 feet southwest and hydraulically downgradient from Roosevelt Field. Five soil vapor samples were collected from 10 feet below grade around the perimeter of the Stewart School (5 to 10 feet from the building). Groundwater samples also were collected at each soil gas sampling location. No VOCs or chlorinated VOCs were detected in groundwater or soil vapor (H2M 1993).

1.4.2 EPA Remedial Investigation

From June 2005 to December 2006, CDM performed the RI at the site. The RI included a hydrogeological investigation, a source area soil gas investigation, an ecological investigation, and a Stage 1 culture resource survey (CDM 2007). Activities for the hydrogeological and source area soil gas investigation are listed below and summarized in Table 1-2.

Hydrogeological Investigation

- Conducted a geophysical utility survey to locate underground utilities at drilling locations
- Collected discrete-depth groundwater screening samples at 20-foot intervals for 24-hour turnaround VOC analysis to assist in selection of multi-port well screen intervals at 8 locations
- Conducted borehole natural gamma logging in eight multi-port well borings
- Installed and developed 4-inch diameter outer screen and casing assemblies to support the multi-port monitoring well equipment
- Installed Westbay multi-port well equipment at eight locations
- Collected two rounds of hydrostatic pressure and synoptic water level measurements
- Re-developed nine existing monitoring wells
- Collected two rounds of groundwater samples from eight multi-port monitoring wells, nine existing monitoring wells, and two public supply wells

Source Area Soil Gas Investigation

- Conducted geophysical utility survey to locate underground utilities
- Installed temporary soil gas points and conducted soil gas screening using Geoprobe soil gas sampling apparatus and ppbRAE in the source area at 158 locations at two depths: 15 feet bgs and 35 feet bgs
- Collected 36 soil gas samples using canisters adjacent to three office buildings and along Clinton Road (Hazelhurst Park), for laboratory analysis using method TO-15

The locations of newly installed and existing monitoring wells and two supply wells are shown on Figure 1-4. The location of the soil gas investigation are shown in Figure 1-5a and 1-5b.

1.5 Physical Characteristics of the Study Area

1.5.1 Surface Features

The site is located within the Atlantic Coastal Plain of New York. The topography of the central portion of Nassau County is characterized by a gently southward-sloping glacial outwash plain. The site is flat to gently undulating with slopes from approximately 100 feet above mean sea level (msl) at the northern edge (along Old Country Road) down to approximately 70 feet above msl about 4,000 feet south-southwest of Roosevelt Field, along Clinton Road.

1.5.2 Site Geology

The site is located within the Atlantic Coastal Plain Physiographic Province. The geology of Long Island is characterized by a southeastward-thickening wedge of unconsolidated sediments unconformably overlying a gently-dipping basement bedrock surface. The wedge ranges in thickness from zero feet beneath Long Island Sound to the north, on the submerged western margin of the Coastal Plain, to more than 2,000 feet under the southern shores of Long Island. In the vicinity of the Roosevelt site the sedimentary units thicken from about 800 feet at the northern edge of the Town of Hempstead to approximately 1,500 feet thick beneath the barrier islands.

The geologic units at the site consist of:

- Basement - Precambrian to Early Paleozoic igneous or metamorphic bedrock
- Raritan Formation - Cretaceous Lloyd Sand Member (sand and gravel) and the overlying Raritan Clay Member (clay and silt as a confining layer)
- Magothy Formation - Cretaceous fine to medium quartz sand, interbedded clayey sand with silt, clay, and gravel interbeds or lenses, Interbeded clay is more common toward the top of the formation.
- Pleistocene Deposits - only the Upper Glacial deposits are identified at the site. The Upper Glacial deposits are composed mainly of stratified beds of fine to coarse-grained sand and gravel; thin beds of silt and clay are interbedded with coarse-grained material

The Upper Glacial deposits and the Magothy Formation are the geologic units of interest for the site.

1.5.3 Site Hydrogeology

The Upper Glacial and Magothy aquifer is unconfined and forms a single aquifer unit, although with different properties. In the Roosevelt Field vicinity, the depth to water ranges from 20 to 50 feet below the ground surface (bgs), the saturated thickness of the Upper Glacial aquifer ranges from 20 to 40 feet; the thickness of the Magothy aquifer is about 500 feet. They are the most productive and heavily utilized groundwater resource on Long Island. Average transmissivities are 240,000 gallon per day per foot (gpd/ft) for the Magothy aquifer and 200,000 gpd/ft in the Upper Glacial aquifer. Average hydraulic conductivities are 228 feet per day (ft/d) in the Upper Glacial and 56 in the Magothy (Krulikas 1987).

During the RI, the depth to the water table at the site was measured between 27 and 37.6 feet bgs. The general horizontal hydraulic gradient is to the south. Based on RI Round 1 data for the shallow aquifer, the groundwater flow gradient is 0.00156. Given this flow gradient, an effective porosity of 0.15, and the conductivity for the Magothy aquifer (approximately 56 ft/d), the flow rate is estimated to be 0.6 ft/d.

Water level elevation data from the multi-port wells installed during the RI provided an opportunity to evaluate vertical hydraulic gradient within each well location. In all multi-port wells, the vertical groundwater flow is downward. The four multi-port wells in the mall area have similar vertical gradients, with the differences between water levels in the shallow and deep ports within each well ranging from 1.8 to 2.9 feet. Further to the south, the vertical gradients become larger: 3.2 feet in SVP-7, 8.2 feet in SVP-8, and 9.7 feet in SVP-6. The higher vertical gradients in SVP-8 and SVP-6 are most likely caused by groundwater extraction of Hempstead municipal supply wells, approximately one block from the multi-port wells.

1.5.4 Surface Water Hydrology

No naturally-occurring surface water bodies are present in the vicinity of the Roosevelt site. Almost the entire site area is paved or is occupied by buildings. Any runoff is routed into storm water collection systems and commonly is discharged directly to either to dry wells or to recharge/retention basins. In general, the sandy nature of natural soils on Long Island promotes fast infiltration of precipitation (rainwater) from the ground surface.

The Pembrook recharge basin and two Nassau County recharge basins are man-made recharge basins located on or near the site. One of the Nassau County basins is located immediately south of the Pembrook Basin, approximately 1,500 feet southwest of the Roosevelt Field Shopping Center; the other county recharge basin is located about 1,000 feet southeast of the shopping center (see Figure 1-2). The privately-owned Pembrook Basin formerly received cooling water discharge (Eckhardt 1989). Currently it appears to receive surface water runoff during storm events. The Nassau County basins receive storm runoff from the municipal storm water collection system.

1.5.5 Population and Land Use

The Roosevelt site is located in a very densely developed portion of Nassau County. The current land use for the area surrounding the site is mixed commercial and residential. The site is in East Garden City (area is 3.0 square miles) within the Town of Hempstead. East Garden City supports 979 residents, 275 households and 243 families. Of the 275 households, 47.6 percent have children under the age of 18 living with them. The Village of Garden City (area is 5.3 square miles) lies south and west of the site. Garden City supports approximately 21,672 residents, 7,386 households and 5,857 families. Of the 7,386 households, 36.1 percent have children under the age of 18 living with them. The Roosevelt Field Mall is the largest in New York State and the 11th largest in the United States, with an area of 2,146,000 square feet. The mall provides employment for several thousand people and receives millions of visitors each year (US Census Bureau 2005).

The former Roosevelt Field is characterized by commercial office development on the west (Garden City Plaza); a large regional shopping mall complex on the east (Roosevelt Field Shopping Center); an area occupied by undeveloped woodland, recharge basins, and Stewart Avenue School immediately south of the office park; and mixed retail/commercial businesses south of the shopping mall. South of Stewart Avenue is an area of retail strip development, commercial, and light industrial development. This area includes several state and federal hazardous waste sites that formerly released solvents to groundwater (Pasley, Purex, and Win-Holt sites). Beyond that, to the south and south-southwest, land use is predominantly single family residential. Homes in this area of Garden City and Hempstead use the municipal water supply pumped from village well fields for potable drinking water and the municipal sewer system for sanitary waste water disposal.

1.5.6 Cultural Resource Assessment

John Milner Associates, Inc. (JMA) completed a Stage 1A culture resources survey of the site in 2005. This survey covered two areas: the Source Area consists of Roosevelt Field Shopping Center, a number of office buildings on the perimeter, Hazelhurst Park, and the area with Garden City supply wells GWP-10 and GWP-11. The downgradient area encompasses approximately 160 acres, consisting of the residential neighborhood.

The Stage 1A culture resources survey concluded that significant prior ground disturbance could be anticipated for the entire downgradient area and the majority of the mall/office complex area. JMA does not recommend any additional cultural resources work associated with remediation activities that may occur in these portions of the site. Small portions of the mall/office complex area along the western edge and at the southwestern corner (recharge basin) are presently undeveloped. Remnants of the historic Long Island Motor Parkway are present within this portion of the site. This area should be considered sensitive for archeological resources. If remediation activities involving ground disturbance are necessary within the undeveloped portions of the site, JMA recommends that a Stage 1B culture resources survey be conducted prior to the remediation activities. If remediation activities are necessary in the vicinity of the remnants of the Long Island Motor Parkway, JMA recommends that a Stage II analysis be conducted in order to determine if this portion of the Parkway is eligible for the State and National Register of Historic Places.

1.6 Nature and Extent of Contamination

1.6.1 Groundwater Contamination

1.6.1.1 Site-related Contaminants and Groundwater Screening Criteria

To focus the evaluation of the nature and extent of groundwater contamination, the site-related contaminants were identified during the RI: PCE, TCE, cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE), and carbon tetrachloride. PCE and TCE were likely used at the site for aircraft maintenance and repair operations. 1,1-DCE and cis-1,2-DCE can be degradation products of PCE and TCE. Carbon tetrachloride was commonly used as a refrigerant and was likely associated with the cooling systems in the office buildings.

Groundwater screening criteria were selected to evaluate contaminants detected at this site. Whenever possible, established regulatory criteria, known as chemical-specific applicable or relevant and appropriate requirements (ARARs) were used. The criteria considered were EPA's National Primary Drinking Water Maximum Contaminant Levels (MCLs), New York State Standards and Guidance Values for Class GA groundwater (Human Water Source), and NYSDOH drinking water standards. The criteria selected for the five site-related contaminants are all at 5 µg/L.

During the RI, PCE, TCE, cis-1,2-DCE and 1,1-DCE were detected at concentrations above the groundwater screening criteria. Methyl tert-butyl ether (MTBE), toluene, dichlorodifluoromethane, and trichlorofluoromethane were also detected in groundwater samples at concentrations above the groundwater screening criteria. However, these compounds are not considered site-related contaminants. Dichlorodifluoromethane and trichlorofluoromethane were used as coolants, and were probably discharged to the groundwater with cooling water. MTBE and toluene were likely from gasoline spills not related to the site.

1.6.1.2. Groundwater Contamination in the Upper Glacial Aquifer

During the RI, two rounds of groundwater samples were collected from four existing monitoring wells in the Upper Glacial aquifer. They are GWX-9953, GWX-9966, GWX10035, and GWX-9398. Groundwater screening samples were collected within the Upper Glacial aquifer from eight boring locations before installation of the Westbay multiport monitoring wells (Tables 1-3 to 1-7). After installation, each Westbay multiport monitoring well has the shallowest port at approximately 50 feet bgs, in the Upper Glacial aquifer or in the transition zone between the Upper Glacial aquifer and the Magothy aquifer. Two rounds of groundwater samples were collected from these multiport monitoring wells.

TCE and PCE concentrations above 0.5 µg/L, the laboratory detection limit, were detected in SVP-2, SVP-3, SVP-4, SVP-5, SVP-6, SVP-8, and GWX-10035 (Tables 1-4 to 1-6). Compounds other than PCE/TCE and their degradation products (cis-1,2-DCE and trans-1,2-DCE) were detected in groundwater samples collected from the Upper Glacial aquifer at concentrations below the groundwater screening criteria. For example, dichlorodifluoromethane, MTBE, methylene chloride, 1,1-dichloroethane, and 1,1,1-trichloroethane (1,1,1-TCA) were detected at very low concentrations. High concentrations of toluene were detected in SVP-6, but toluene is not considered a site-related contaminant.

1.6.1.3 Groundwater Contamination in the Magothy Aquifer

During the RI, two rounds of groundwater samples were collected from five existing monitoring wells and eight newly-installed multiport monitoring wells in the Magothy Aquifer. Groundwater samples were also collected at the tap from the two Garden City supply wells GWP-10 and GWP-11, which are also screened in the Magothy aquifer. Groundwater screening samples were collected from eight borings prior to multiport monitoring well installation at 20-foot intervals between 450 feet bgs to 50 feet bgs. Analytical results of these samples are in Table 1-1, Table 1-3, Table 1-4, Table 1-5, Table 1-6, and Table 1-7 and discussed below based on their spatial locations.

<u>Upgradient Area</u>

Multiport monitoring well SVP-1 is located upgradient of the site. Some low levels of VOCs were detected in the deeper portions of the well (250 to 400 feet bgs) as seen in Tables 1-4 and 1-5. All detections of VOCs were below the screening criteria. The highest PCE levels were 0.38 J μg/L and 0.8 μg/L during Rounds 1 and 2, respectively, and the highest TCE levels were 0.77 μg/L and 2.4 μg/L, respectively. The highest 1,1-DCE levels were 0.64 μg/L and 4 μg/L. These VOCs are the same as those found at the site; however, as they are upgradient from the site they are from source(s) other than the site.

<u>Old Roosevelt Field</u>

Multiport monitoring wells SVP-2, SVP-3, SVP-4, and SVP-5, existing monitoring wells GWX-10019 and GWX-10020, and the two supply wells GWP-10 and GWP-11 are within the former Old Roosevelt Field area.

<u>SVP-2</u>

PCE, TCE, cis-1,2-DCE, were detected above the groundwater screening criteria. Carbon tetrachloride and 1,1-DCE were detected below the reporting limits with a "J"qualifier. TCE concentrations in all groundwater samples from the nine sampling ports (100 to 455 feet bgs) in the Magothy Aquifer were above the groundwater screening criterion, ranging from 12 to 38 J μg/L. The PCE concentration in one groundwater sample collected from port 5 (290 feet bgs) during Round 1 of sampling was 5.8 μg/L. PCE concentrations from all other samples were below the groundwater screening criterion. Cis-1,2-DCE concentrations from six samples were above the groundwater screening criterion, ranging from 5.2 to 10 μg/L. Samples with site-related contaminant concentrations exceeding the screening criteria were collected from sampling ports 4 and 6 (250 and 355 feet bgs, respectively) during Round 1; and from sampling ports 3 to 6 (between 250 and 375 feet bgs) during Round 2. SVP-2 is closely located to the most contaminated cooling water well (N-8050), at which 41,000 μg/L of total VOCs were detected in 1984. Therefore, groundwater contamination levels at this location have significantly decreased.

SVP-3

TCE concentrations exceeded the groundwater screening criterion at sampling port 3 (290 feet bgs) during the Round 1 and at port 1 to port 3 (370 to 455 feet bgs) during Round 2. The highest TCE concentration was 14 µg/L. Concentrations for PCE, cis-1,2-DCE, 1,1-DCE and carbon tetrachloride were below detection limits or below the groundwater screening criteria.

SVP-4

PCE, TCE, cis-1,2-DCE and 1,1-DCE were detected above the groundwater screening criteria in the Magothy Aquifer. Carbon tetrachloride concentrations were below the groundwater screening criterion or below the detection limits. TCE concentrations ranged from 26 to 280 µg/L during Round 1 from port 1 to port 8 (from 145 to 425 feet bgs); and ranged from 21 J to 200 µg/L during Round 2 from port 1 to port 8 (from 145 to 425 feet bgs). PCE concentrations ranged from 7.3 to 350 µg/L during Round 1 from port 1 to port 9 (from 100 to 425 feet bgs); and ranged from 14 to 210 µg/L during Round 2 from port 1 to port 9 (from 100 to 425 feet bgs). Cis-1,2-DCE was detected at 5.3 J µg/L in the sample collected from port 6 (250 feet bgs) during Round 1; and at 11 J, 5, and 7.8 µg/L in samples collected from port 3 (350 feet bgs), port 4 (310 feet bgs), and port 6 (250 feet bgs), respectively. 1,1-DCE ranged from 5.5 J to 8.9 µg/L in samples collected from port 4 to port 6 (310 to 245 feet bgs) during Round 1; and at 5.8 and 9.7 µg/L from port 1 (425 feet bgs) and port 3 (355 feet bgs), respectively. Historically, the contaminant concentrations from cooling water well N-9311 located east-northeast of SVP-4 had a total VOC concentration at 3,500 µg/L in 1984. Therefore, groundwater contamination levels at this location have significantly decreased.

SVP-5

Only TCE was detected above the groundwater screening criteria at this location. PCE, 1,1-DCE, cis-1,2-DCE, and carbon tetrachloride were non-detect or detected at concentrations below the groundwater screening criteria. TCE concentrations ranged from 5 to 32 µg/L in samples collected from port 1 to port 6 (435 to 250 feet bgs) during both rounds of sampling.

GWX-10019

GWX-10019 is screened between 223 and 228 feet bgs. TCE and cis-1,2-DCE were detected above the groundwater screening criteria. TCE was detected in Rounds 1 and 2 at 260 µg/L and 170 µg/L, respectively and cis-1,2-DCE was detected at 21 µg/L and 23 µg/L, respectively. PCE was detected at 2 µg/L and 2.2 µg/L during Rounds 1 and 2, respectively. Carbon tetrachloride was very low, at 0.2 J and 0.28J µg/L, respectively. 1,1-DCE was not detected in GWX-10019.

The VOC MTBE, which is not site-related, was also detected during both rounds in GWX-10019, at levels exceeding the screening criterion.

GWX-10020

GWX-10020 is screened between 185 and 190 feet bgs. Site-related VOCs were detected in GWX-10020 at levels below the screening criteria. Results include: PCE at 1.3 µg/L

(Round 1); TCE at 1.6 µg/L (Round 1) and 0.14 J µg/L (Round 2); and cis-1,2-DCE at 0.19 J µg/L. 1,1-DCE and carbon tetrachloride were not detected in GWX-10020.

<u>GWP-10 and GWP-11</u>
GWP-10 is screened from 377 to 417 feet bgs; GWP-11 is screened from 370 to 410 feet bgs. Among the site-related contaminants, only carbon tetrachloride was detected at concentrations below the groundwater screening criterion. In general, the contaminant levels in GWP-11 is lower than in GWP-10.

Concentrations of site-related VOCs in GWP-10 during Round 1 and Round 2, respectively, were as follows: PCE at 270 and 230 µg/L; TCE at 170 and 220 µg/L; 1,1-DCE at 5.5 and 12 µg/L; cis-1,2-DCE at 13 and 26J µg/L; and carbon tetrachloride at 0.85 and 1.2 µg/L. Concentrations of site-related VOCs in GWP-11 during Round 1 and Round 2, respectively, were as follows: PCE at 50 and 58 µg/L; TCE at 160 µg/L during both rounds; 1,1-DCE at 4 and 3.7 µg/L; cis-1,2-DCE at 13 and 10 µg/L, and carbon tetrachloride at 0.42J and 0.46J µg/L.

The two supply wells GWP-10 and GWP-11 have historically contained high levels of site-related contaminants since they were first sampled in the 1970s, although levels have shown a decreasing trend since the mid-1990s.

In summary, SVP-4, GWX-10019, and the two supply wells GWP-10 and GWP-11 are in the core of the contaminant plume. PCE and TCE concentrations in this core of the contaminant plume were at a few hundred µg/L. Based on historical sampling data, it would appear that the core of contaminant plume reached the two Garden City supply wells many years ago. Based on the RI results, there are no indication of a sustainable source or sources. The bottom of the contaminant plume has not been clearly defined. Groundwater samples collected from the lowest sampling ports at SVP-2 and SVP-4 had TCE and/or PCE concentrations above the groundwater screening criteria.

The contaminant plume is shown in Figures 1-6 a and b. The plume cross section is shown in Figure 1-7.

<u>Downgradient Area</u>
Multiport monitoring wells SVP-6, SVP-7, and SVP-8 are located downgradient and to the south of the Roosevelt Field mall area. Existing monitoring wells GWX-8068 (265-291 feet bgs), located in the office building at 585 Stewart Avenue, near the southern mall entrance; and GWX-8474 (485-556 feet bgs) and GWX-8475 (409-481 feet bgs), are both housed inside a pump house on Oak Street, west of SVP-6.

<u>SVP-6</u>
SVP-6 is located in a residential area on Meadow Street. It is downgradient of the Roosevelt Field mall area, and is also downgradient of three other contaminant sites (Pasley, Purex, and Win-Holt) in the area. This well was installed to act as a sentinel well for the Village of Hempstead well field. TCE, 1,1-DCE and cis-1,2-DCE exceeded screening criteria in this well at the following depths: TCE at 8.2 µg/L in sample

collected from port 3 (245 to 250 feet bgs) during Round 1; cis-1,2-DCE at 22 J µg/L in sample collected from port 5 (100 to 105 feet bgs) during Round 1; 1,1-DCE ranged from 6.7 to 22 µg/L between port 3 and port 5 (250 to 100 feet bgs) during both rounds. The highest levels were generally found in shallower zones of this well, with the highest levels in port 5. Since the contamination in the Roosevelt Field mall area is concentrated in deeper zones than contamination is detected in this well, the contamination in SVP-6 may have originated from a source other than the Roosevelt Field site. In addition, several other VOCs that are not site-related (such as acetone and toluene) were also found in this well, at levels far exceeding screening criteria.

The following VOCs exceeded screening criteria in SVP-6: acetone, toluene, 1,1-DCA, 1,1,1-TCA. The highest acetone concentration was 130 µg/L, and the highest toluene concentration was 810 µg/L. These VOCs are not considered to be site-related because they were not known to be used when Roosevelt Field was an airfield.

SVP-7

SVP-7 is located in a residential area west of Commercial Avenue, along the former Long Island Railroad (LIRR) tracks. PCE, TCE, and 1,1-DCE exceeded screening criteria at this location as following: PCE at 7.7 µg/L in port 3 (310 to 315 feet bgs) during round 2; TCE at 9.4 µg/L in port 3 during Round 1 and at 6.2 and 20 µg/L in port 2 and 3, respectively during Round 2; 1,1-DCE at 5.2 µg/L in port 2 (425-430 feet bgs) during Round 1. Carbon tetrachloride was not detected in any of the samples from this well.

This well contained the least amount and lowest concentrations of VOC contamination of all the multiport wells. It is likely this well is near the western extent of the contaminant plume associated with the Roosevelt site or the contamination may be related to another upgradient site (Johnson and Hoffman) with similar contaminants. This well was originally planned to be installed directly downgradient of the source area, but was moved west due to access issues for large drilling equipment.

No other VOCs exceeded screening criteria during either round of sampling.

SVP-8

SVP-8 is the furthest downgradient multiport well from the Roosevelt Field mall area, in a residential area on the corner of Clinton Road and Meadow Street. It is due west of SVP-6, and similarly to that well, is downgradient of three other contaminated sites and is a sentinel well for the Village of Hempstead well field. PCE is the only site-related VOC that exceeded the screening criteria in this well. PCE ranged from 15 to 34 µg/L in port 3 to 5 (240 to 100 feet bgs) during Round 1; and ranged from 6.7 to 57 µg/L in port 1 to 5 (440 to 100 feet bgs) during Round 2. The highest levels were found in shallower zones of this well, specifically in port 5. As in SVP-6, the contamination in SVP-8 may have originated from a source other than the Roosevelt Field site. TCE was detected during both rounds, in all but the shallowest sample; the highest concentrations during Round 1 and 2 were 1.9 and 3.2 µg/L, respectively. Cis-1,2-DCE was only detected in three samples, at very low estimated levels, during each round. 1,1-DCE and carbon tetrachloride were not detected in any samples at this well.

GWX-8068

GWX-8068 (265-291 feet bgs) is located in the office building at 585 Stewart Avenue near the southern mall entrance. This well is not within the direct flow path of the contamination identified on the western side of the Roosevelt Field mall complex. GWX-8086 was only sampled during Round 2, due to access issues during Round 1. This well also contained high levels of site-related VOCs, with all but carbon tetrachloride results exceeding screening criteria. Results during Round 2 include: PCE at 170 μg/L, TCE at 54 μg/L, 1,1-DCE at 17 μg/L, cis-1,2-DCE at 5.3 J μg/L, and carbon tetrachloride at 0.44 J μg/L.

The VOC 1,1,2-trichloro-1,2,2-trifluoroethane, which is not site-related, was detected slightly above the screening criterion.

GWX-8474 and GWX-8475

GWX-8474 (485-556 feet bgs) and GWX-8475 (409-481 feet bgs), both located inside a pump house on Oak Street, east of SVP-6. These wells are not within the direct flow path of contamination emanating from Roosevelt Field. The five site-related VOCs were detected in GWX-8474 during Round 1. PCE and TCE exceeded screening criteria during both rounds; 1,1-DCE exceeded screening criteria during round 2. PCE and TCE were detected at 5.8 and 29 μg/L during Round 1 and at 6.3 and 25 μg/L during Round 2. 1,1-DCE and carbon tetrachloride were detected only during Round 2, at 7.4 and 0.42 J μg/L, respectively. Cis-1,2-DCE was detected during both rounds, at 0.76 and 1.4 J μg/L, respectively.

PCE, TCE, and 1,1-DCE exceeded screening criteria in GWX-8475. PCE was detected at 5.5 μg/L (Round 1) and 3.7 μg/L (Round 2). TCE was detected at 24 μg/L and 16 μg/L during Rounds 1 and 2, respectively. 1,1-DCE was detected at 17 and 20 J μg/L, respectively. Cis-1,2-DCE was detected at 1.2 and 0.79 J μg/L, respectively. Carbon tetrachloride was not detected in GWX-8475.

Several other non-site-related VOCs were also detected in existing wells GWX-8474 and GWX-8475, such as 1,1,2-trichloro-1,2,2-trifluoroethane (at levels exceeding screening criteria), 1,1-DCA, 1,1,1-TCA, and 1,1,2-TCA. The contamination in these wells may have originated from sources other than those at Roosevelt Field since several non-site-related VOCs were detected in these wells, and the wells are located downgradient of other potential contaminant sources.

1.6.1.4 Evaluation of Groundwater Contamination

The results from both rounds of groundwater samples collected during the RI indicate the highest levels of PCE and TCE (350 and 280 μg/L, respectively) are concentrated at SVP/GWM-4, at elevations ranging from approximately -221 to -156 feet below msl (approximately 250 to 310 feet bgs). It should be noted that the SVP-4 location was selected for monitoring because a distilling well/drain field was operated in the area during the 1980s, to dispose of cooling water contaminated with the site-related

VOCs. The next highest levels occur downgradient (to the south) of SVP/GWM-4 in existing well GWX-10019, at a slightly shallower depth at approximately 223 to 228 feet bgs, and at the two Village of Garden City supply wells GWP-10 and GWP-11, at approximately 370 to 417 feet bgs, 150 feet deeper than the highest contaminant zone in SVP/GWM-4. These four wells comprise the core of the PCE/TCE contaminant plume.

GWP-10 and GWP-11 each have a capacity to pump approximately one mgd of groundwater from the Magothy aquifer (with the wells pumping alternately), and as a result, have a direct influence on the localized groundwater flow. Groundwater flow and contaminant movement are downward and to the south. Low levels of site-related contamination are observed in the sentinel wells south (downgradient) of the two supply wells.

Multi-port well SVP/GWM-7, located southwest of the supply wells, contained relatively low levels of site-related contaminants, but TCE and PCE exceeded the screening criteria. Further downgradient of the supply wells, PCE and TCE contaminant levels in the most downgradient multiport well (SVP/GWM-8) are seen at shallower depths than at the plume core in the mall area. Several sources of VOC contamination (Pasley, Purex, and Win-Holt) are in the area south of the Roosevelt site. Given the shallower depth of contamination at the downgradient wells in the residential area, the detected VOCs are not likely associated with the Roosevelt Field site. The contamination at the downgradient multiport wells (SVP-6 and SVP-8) is likely to be related to other sources of groundwater contamination. Groundwater contamination from the Roosevelt site may have migrated beyond the two Village of Garden City supply wells in the years between about 1940 and 1953 before the wells began pumping. However, contamination that may have moved further south than these wells may have been drawn into the pumping cone of influence created by the large volume of water withdrawn by these wells on a continuing basis.

Very deep groundwater contamination (TCE at 10.1 and 9.2 μg/L) was recently detected in two of the Village of Hempstead supply wells, located just south (downgradient) of multiport monitoring wells SVP/GWM-6 and SVP/GWM-8 (Figure 1-8). The source of this contamination is currently unknown, as several potential sources are located upgradient of the Hempstead well field.

1.6.2 Soil Gas

1.6.2.1 Soil Gas Screening Criteria

Soil gas screening criteria were selected from the EPA 2002 document titled *Draft Document for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soil*. This document provides potential screening criteria for VOCs based on risk levels (e.g., 10^{-4}, 10^{-5} or 10^{-6}) and the depth of the sample. The site-specific soil gas screening criteria for PCE, TCE, cis-1,2-DCE, 1,1-DCE and carbon tetrachloride are 81, 2.2, 3,500, 20,000, and 18 micrograms per cubic meter (μg/m^3), respectively, based on risk of 10^{-6} in the EPA guidance. The deep soil gas column was utilized in Table 2c in the EPA guidance, based on the depth of approximately 15 feet for the soil gas samples. NYSDEC and NYSDOH have no subsurface soil vapor criteria (NYSDOH 2006).

1.6.2.2 Soil Gas Survey Results

Two types of soil gas samples are discussed in the sections below. Soil gas screening samples were collected at the nodes of a 100-foot by 100-foot grid from 158 locations in a large portion of the paved and unpaved areas of the site bordering Old Country Road and Clinton Road. Measurements of total VOCs were made with a ppbRAE instrument at two depths at each location (approximately 15 and 35 feet bgs). Soil gas samples were collected in Summa canisters, from depths of 15 feet bgs at 30 locations adjacent to buildings 100 and 200 in the Garden City Plaza office complex, and at 100 Ring Road. In addition, six canister samples (from four different locations) were collected from Hazelhurst Park (the grassy strip along Clinton Road) where the screening survey results were elevated. Soil gas survey results are shown in Figures 1-9 to 1-11.

<u>Soil Gas Screening Samples</u>

Of all the soil gas total VOC readings by ppbRAE collected at approximately 15 feet bgs, 85 percent were at or below 10 parts per billion per volume (ppbv); 8 percent were between 11 and 50 ppbv, and 4 percent were between 51 and 100 ppbv. Five of the soil gas samples had total VOC readings above 100 ppbv. They were:

- Location A0 - This location is at the corner of Old Country Road and Clinton Road. The total VOC reading was 106 ppbv.
- Location A11 - This location borders Clinton Road in Hazelhurst Park. The total VOC reading was 136 ppbv. Canister samples SGHP2 and SGHP4 were collected near this location.
- Location D17 - This location is just west of Garden City Plaza Building 100. The total VOC reading was 531 ppbv. Canister sample SGRF30 was collected near this location.
- Location D19 - This location is west of Garden City Plaza Building 200. The total VOC reading was 534 ppbv.
- Location F20 - This location is south of Garden City Plaza Building 200. The total VOC reading was 163 ppbv. Canister sample SGRF32 was collected near this location.

Of all the soil gas total VOC readings by ppbRAE collected at approximately 35 feet bgs, 83 percent were at or below 10 ppbv; 9 percent were between 11 and 50 ppbv, and 2.5 percent were between 51 and 100 ppbv. Nine of the samples had total VOC readings above 100 ppbv. The highest detection was 494 ppbv, at the same location with highest VOC readings at 15 feet bgs, west of Garden City Plaza Building 200.

- Locations A9, A10, and A11 - These locations border Clinton Road in Hazelhurst Park. The total VOC readings were 245 ppbv, 233 ppbv, and 148 ppbv, respectively. Canister samples SGHP1, SGHP2, and SGHP3 were collected near these locations.

- Location B15 - This location is west of the northwest corner of Garden City Plaza Building 100. The total VOC reading was 368 ppbv.
- Location C20 - This location is one of the southern-most samples. The total VOC reading was 112 ppbv.
- Location D17 - This location is just west of Garden City Plaza Building 100. The total VOC reading was 494 ppbv. Canister sample SGRF30 was collected near this location.
- Location E14 - This location is north of the northeast corner of Garden City Plaza Building 100. The total VOC reading was 211 ppbv.
- Location H1 - This location is southeast of the Citibank building, near the entrance road to the mall. The total VOC reading was 152 ppbv.
- Location K0 - This location is on the eastern side of the mall entrance road. The total VOC reading was 185 ppbv.

<u>Soil Gas Analytical Results</u>
One sample near Garden City Plaza building 200 (SGRF-25 at 23 $\mu g/m^3$) and three samples collected along Hazelhurst Park (adjacent to Clinton Road) had TCE detections that exceeded the screening criterion: SGHP-2 at 3.9 J, SGHP-3 at 12, and SGHP-4 at 3 J $\mu g/m^3$. Soil gas sample results are found in Table 1-8. It should be noted that the contract required detection limit for TCE exceeded the screening criterion; it ranged from 5.2 to 5.8 $\mu g/m^3$.

The soil gas survey indicated a few areas with elevated soil gas, but levels do not indicate the presence of any residual contamination sources in the vadose zone. To confirm these conclusions, EPA recently collected additional vapor samples on the west side of Clinton Road and at several office buildings in the mall area. In addition, EPA collected soil samples at all soil gas screening locations that exceeded 100 ppbv. The results can be found in separate documents in the administrative record for the site.

1.6.3 Contaminant Fate and Transport

The fate of a contaminant in the environment is determined by its physical and chemical properties, the geology it is released into, groundwater velocity, the geochemical conditions in the aquifer, the rate of degradation and the adsorption coefficient (K_d). Values for K_d and calculated retardation factors are provided in Table 1-9.

Among the five site-related contaminants, PCE and TCE are the primary contaminants. Carbon tetrachloride was only detected at concentrations below the groundwater screening criteria, therefore it is not a concern. Cis-1,2-DCE is an anaerobic degradation product of PCE and TCE. 1,1-DCE can be an abiotic degradation product of TCE.

Pure phase PCE and TCE are dense non-aqueous phase liquids (DNAPL). They are heavier than water and have low viscosities. If released to the ground, they tend to penetrate deep into the subsurface. PCE and TCE have relatively low solubilities and high Henry's law constant, which means they are highly volatile. Residual PCE and TCE along their penetration path(s) would vaporized in the vadose zone or dissolved in groundwater below the water table. At this site, no residual DNAPL was found, and there are no indications that DNAPL is present. Therefore, the site-related contaminants in groundwater are believed to be in the dissolved phase.

All site-related contaminants have low K_d values, which means that they have low adsorption capacity. Therefore, the retardation factors for the contaminants are low and they are mobile and are expected to move with the groundwater, although at a relatively slower rate.

The degradation pathways for site-related contaminants are depicted in Figure 1-12. The most frequently observed and typically the most effective degradation pathway for PCE and TCE in the subsurface is via anaerobic dechlorination processes, in which PCE would be degraded to TCE, then to cis-1,2-DCE and trans-1,2-DCE, then to vinyl chloride, and finally to ethene. At this site, natural attenuation via biodegradation appears to be limited due to the aerobic conditions found in the aquifer, which are not suitable for anaerobic dechlorination. Vinyl chloride has never been detected in site samples.

1.6.4 Site Conceptual Model

Although there is no historical documentation for this, it is likely that chlorinated solvents (PCE and TCE) were used at Roosevelt Field during and after World War II. Beginning in the late 1930s, the U.S. Military issued protocols for use of solvents such as TCE for cleaning airplane parts and for de-icing. The types of airplanes designated for solvent use were present at Roosevelt Field. The wasted PCE and TCE could have been directly discharged to the ground surface, a common practice at that time, resulting in contaminated groundwater. The use of PCE and TCE most likely ceased in the early 1950s when the airfield was closed.

The geologic formations of concern at the site are the Upper Glacial deposits and the Magothy Formation. The Upper Glacial deposits consist predominantly of sand and gravel of fairly uniform particle size. The Magothy Formation consists of sand, clayey sand, sandy clay, clay, lignite and some gravel in the basal section. The Magothy Formation has considerable lateral and vertical heterogeneity. The thickness of the Upper Glacial aquifer ranges from 20 to 40 feet at 25 to 50 feet bgs. The thickness of the Magothy aquifer is about 500 feet in the vicinity of the site. The Upper Glacial aquifer and the Magothy aquifer are in direct hydraulic contact and form a single, connected aquifer.

In the 1950s, the site was under significant construction; excavations for the foundations of the mall and several office complexes could have removed some surface and shallow subsurface contamination. Garden City supply wells GWP-10 and GWP-11, located at the southwestern corner of Old Roosevelt Field, have been in operation since 1953. The total volume of groundwater extracted per year from these two wells reached the current level within two years, an average of 400 million gallons per year. Seven cooling water pumping wells also extract groundwater from the Magothy aquifer between the 1960s and the mid-1980s. They are N-5507, N6045, N-8050, N-8068, N-8458, N-9310, and N-9311. The combined pumpage from these cooling water wells was about 4 MGD during the cooling season. The general groundwater flow direction at the site is south, slightly southwest. However, the large scale pumping altered the natural groundwater flow and enhanced the downward movement of contaminants.

During the 1983 and 1984 USGS investigation (Eckhardt 1989), a total VOC concentration (mainly TCE and PCE) as high as 41,000 μg/L was found in cooling water well N-8050. Total VOC concentrations in cooling water wells N-9310 and N-9311 were also above 1,000 μg/L. However, during the RI sampling in 2006, maximum concentrations of PCE and TCE in SVP-2, in the vicinity of N-8050, were 5.8 μg/L and 38 J μg/L, respectively. The highest contaminant levels in the mall area were found in SVP-4, south and downgradient from SVP-2, near the location of a former drain field used to dispose of contaminated cooling water in the 1960s to mid-1980s. The maximum detections of PCE and TCE in SVP-4 were 350 μg/L and 280 μg/L, respectively. Contaminant concentrations in the groundwater have significantly decreased.

The reduction of contamination levels at the site would be a result of combined natural groundwater flushing and groundwater pumping by the cooling water wells and the Garden City supply wells. Cooling water wells extracted huge volumes of contaminated groundwater from the subsurface and thus reduced the total mass of contaminants at the Old Roosevelt Field. The contaminants were redistributed to the subsurface through recharge basins and the drain field, but at lower concentrations (approximately 500 μg/L in 1984 during the USGS investigation). The two supply wells, GWP-10 and GWP-11, because of the large volume of water they extract, have influenced the downgradient migration of contaminants in the Magothy aquifer. These two wells were first sampled in 1977; PCE and/or TCE were detected at very low levels. The contaminant concentrations detected in these two wells gradually increased and reached their highest value, more than 1,000 μg/L in the mid to late 1990s. Since then, the PCE and TCE concentrations have decreased. RI samples collected in 2006 indicated PCE and TCE detected in well GWP-10 were at similar levels as SVP-4. Contaminant concentrations in well GWP-11 are generally lower than well GWP-10.

No residual contaminant sources were identified in the vicinity of the former airfield, based on the results of the soil gas survey and the subsequent soil sampling, which detected no VOCs.

1.7 Risk Assessments

1.7.1 Human Health Risk Assessment

This section presents a summary of the carcinogenic risks and noncarcinogenic hazards for exposures to contaminants in groundwater at the site that were quantitatively evaluated for potential health threats. A summary of these results can be found in Table 1-10 for RME values and Table 1-11 for CTE values.

Future Site Workers
Risks and hazards were evaluated for incidental ingestion of groundwater. The total incremental lifetime cancer risk estimates are:

- RME cancer risk: 2×10^{-4}
- CTE cancer risk: 6×10^{-5}

The RME cancer risk is slightly above the EPA's target range of 1×10^{-6} to 1×10^{-4}.

HIs greater than 1 indicate the potential for non-cancer hazards. The calculated HIs are:

- RME HI: 3
- CTE HI: 3

The total HI based on individual health endpoints for the RME and CTE scenario is above EPA's acceptable threshold of 1 and could possibly have adverse effects on the central nervous system. TCE contributes most of the potential non-cancer hazard.

Future Residents
Risks and hazards were evaluated for incidental ingestion, inhalation and dermal contact with contaminated groundwater. The total incremental lifetime cancer risk estimates are:

- Adult: RME cancer risk: 2×10^{-3} and CTE cancer risk: 3×10^{-4}
- Child: RME cancer risk: 6×10^{-3} and CTE cancer risk: 8×10^{-4}

These estimates are above EPA's target range of 1×10^{-6} to 1×10^{-4}. Exposure to PCE and TCE in groundwater account for the majority of the risk.

HIs greater than 1 indicate the potential for non-cancer hazards. The calculated HIs are:

- Adult: RME HI: 10 and CTE HI: 6
- Child: RME HI: 35 and CTE HI: 10

The total HI based on individual health endpoints is above EPA's acceptable threshold of unity (1). Target organ HIs for the liver, kidney, fetus, and central nervous system also above EPA's threshold of unity due to contamination of TCE in groundwater.

Screening of deep soil gas samples against values in EPA's 2002 *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway* indicates that the potential for vapor intrusion exists on-site. Therefore, any structures constructed there in the future should be evaluated for soil vapor intrusion until groundwater and soil gas concentrations reach levels that would no longer be of concern. More information about the vapor intrusion investigation at the site can be found in a separate report in the administrative record.

1.7.2 Ecological Risk Assessment

A Screening Level Ecological Risk Assessment was not conducted. VOCs in the groundwater are the primary contaminants, and groundwater is the primary medium of concern at the site. Given that groundwater does not discharge to a surface water body, which prevents exposure to any potential ecological receptor at the site, a conclusion can be reached that there are no completed pathways present at the site for ecological receptors. In addition, the RI investigation concluded that the source areas are no longer present at the site, which prevents any potential exposure to contaminated soil for ecological receptors. Based on this information, there is adequate information to conclude that ecological risks are negligible and, therefore, there is no need for remediation on the basis of ecological risk.

1.8 Conclusions

1.8.1 Groundwater Conclusions

Based on data collected during the RI, the following conclusions regarding groundwater contamination at the Roosevelt Field site are presented.

- The main VOCs associated with the Roosevelt site groundwater contamination are: PCE, TCE, 1,1-DCE, cis-1,2-DCE, and carbon tetrachloride.

- The TCE/PCE contaminant plume has migrated south from the area used as an airfield prior to 1951. The natural southerly flow of groundwater has been interrupted by large scale pumping at the two Village of Garden City supply wells south of the mall complex.

- At the SVP/GWM-4 area, the core of the plume is located at approximately 250 to 310 feet bgs. This area was formerly used as a drain field/distilling well for subsurface disposal of cooling water that was contaminated with the site-related VOCs.

- South of the two Village of Garden City supply wells, VOC contamination is shallower, and is like to be related to other contaminant sources south of the Roosevelt Field site.

1.8.2 Soil Gas Conclusions

Based on data collected during the RI source area soil gas investigation, the following conclusions regarding soil gas at the Roosevelt Field site are presented.

- One small soil gas hot spot was noted from soil gas samples analyzed via method TO-15 in an area of Hazelhurst Park, along Clinton Road, west of the office building at 100 Ring Road. EPA evaluated this hot spot with both additional vapor samples on the west side of Clinton Road and with soil samples analyzed for VOCs. The results of these additional samples can be found in a separate report in the administrative record.

- Most detected VOC compounds are associated with gasoline and are not the site-related VOCs.

2

Section Two

Section 2
Development of Remedial Action Objectives and Technology Screening

Remedial action objectives (RAOs) are media-specific goals for protecting human health and the environment. Remedial alternatives are developed to meet the RAOs. The process of identifying the RAOs follows the identification of affected media and contaminant characteristics; evaluation of exposure pathways, contaminant migration pathways and exposure limits; and the evaluation of contaminant concentrations that will result in unacceptable exposure. The RAOs are based on regulatory requirements which may apply to the various remedial activities being considered for the site. This section of the RI/FS reviews the affected media and contaminant exposure pathways and identifies Federal, State, and local regulations that may affect remedial actions.

Preliminary Remediation Goals (PRGs) were selected based on federal or state promulgated applicable or relevant and appropriate requirements (ARARs) and risk-based levels, with consideration also given to other guidelines. These PRGs were then used as a benchmark in the technology screening, alternative development and screening, and detailed evaluation of alternatives presented in the subsequent sections of the FS report.

2.1 Identification of Remedial Action Objectives

The process of identifying site-specific RAOs follows the identification of site-related contaminants, identification of potentially applicable or relevant and appropriate federal and state regulations and other guidance, and finally, selection of the PRGs based on the ARARs, and guidance values. Generally, where a chemical-specific ARAR exists, it provides the basis for the corresponding PRG; if more than one chemical-specific ARAR exists, the most stringent applicable requirements are generally applied first. The selected PRGs provide the basis for the evaluation of remedial technologies. For this site the PRGs are the groundwater MCLs. A detailed discussion of the PRG development is included in Section 2.3.

In this FS, groundwater contamination is considered, and soil vapor contamination would be addressed, as appropriate, after completion of testing. Five site-related groundwater contaminants were identified in the RI. However, carbon tetrachloride was not detected at concentrations above the groundwater screening criteria during the RI and is not considered further in this FS. The human health risk assessment indicated that PCE and TCE groundwater contamination contributed most of the risk. Therefore, in the FS the contaminants of interest are PCE, TCE, and their degradation products: cis-1,2-DCE, and 1,1-DCE. In this section, RAOs for groundwater are identified as follows:

- Prevent or minimize potential, current, and future human exposures including inhalation, ingestion, and dermal contact with VOC-contaminated groundwater that exceeds the MCLs
- Minimize the potential for off-site migration of groundwater with VOC contaminant concentrations greater than MCLs

- Restore groundwater to beneficial use levels within a reasonable time frame, as specified in the National Contingency Plan (NCP)
- Mitigate site-related vapor migrating into the commercial buildings

2.2 Potential ARARs, Guidelines, and Other Criteria

As required under Section 121 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), remedial actions carried out under Section 104 or secured under Section 106 must be protective of human health and the environment and attain the levels or standards of control for hazardous substances, pollutants, or contaminants specified by the ARARs of federal environmental laws and state environmental and facility siting laws, unless waivers are obtained. According to EPA guidance, remedial actions also must take into account non-promulgated "to be considered" criteria or guidelines if the ARARs do not address a particular situation.

The degree to which these environmental and facility siting requirements must be met varies, depending on the applicability of the requirements. Applicable requirements must be met to the full extent required by law. CERCLA provides that permits are not required when a response action is taken onsite. The NCP defines the term onsite as the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action (40 Code of Federal Regulations [CFR] 300.5). Although permits are not required, the substantive requirements of the applicable permits must be met. On the other hand, only the relevant and appropriate portions of non-applicable requirements must be achieved, and only to the degree that they are substantive rather than administrative in nature.

2.2.1 Definition of ARARs

A requirement under CERCLA, as amended, may be either "applicable" or "relevant and appropriate" to a site-specific remedial action, but not both. The distinction is critical to understanding the constraints imposed on remedial alternatives by environmental regulations other than CERCLA.

Applicable Requirements

Applicable requirements pertain to those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Applicable requirements are defined in the NCP, at 40 CFR 300.5 -- Definitions.

Relevant and Appropriate Requirements

Relevant and appropriate requirements pertain to those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site per se, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate. Relevant and appropriate requirements are defined in the NCP, at 40 CFR 300.5 -- Definitions.

<u>Other Requirements To Be Considered</u>
These requirements pertain to federal and state criteria, advisories, guidelines, or proposed standards that are not generally enforceable but are advisory and that do not have the status of potential ARARs. Guidance documents or advisories "to be considered" in determining the necessary level of remediation for protection of human health or the environment may be used where no specific ARARs exist for a chemical or situation, or where such ARARs are not sufficient to be protective.

<u>Waivers</u>
CERCLA specifies situations under which ARARs may be waived (40 CFR 300.430: Remedial Investigation/Feasibility Study Selection of Remedy). The situations eligible for waivers include:

- The alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement

- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives

- Compliance with the requirement is technically impracticable from an engineering perspective

- The alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach

- With respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state.

- For Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites that may present a threat to human health and the environment Where remedial actions are selected that do not attain ARARs, the lead agency must publish an explanation in terms of these waivers. It should be noted that the "fund balancing waiver" only applies to Superfund-financed remedial actions.

ARARs apply to actions or conditions located onsite and offsite. Onsite actions implemented under CERCLA are exempt from administrative requirements of federal and state regulations (such as permits), as long as the substantive requirements of the ARARs are met. Offsite actions are subject to the full requirements of the applicable standards or regulations (including all administrative and procedural requirements).

Based on the CERCLA statutory requirements, the remedial actions developed in this FS will be analyzed for compliance with federal and state environmental regulations. This process involves the initial identification of potential requirements, the evaluation of the potential requirements for applicability or relevance and appropriateness, and, finally, a determination of the ability of the remedial alternatives to achieve the ARARs.

2.2.2 Identification of ARARs

Three classifications of requirements are defined by EPA in the ARAR determination process: Chemical-specific ARARs; Location-specific ARARs; and Action-specific ARARs. Additionally, TBC criteria are also evaluated.

Each of these groups of ARARs and TBCs is described below. Summaries of the potential ARARs and TBC criteria are provided in Tables 2-1, 2-2, and 2-3.

2.2.2.1 Chemical-specific ARARs and TBCs

Chemical-specific ARARs are health- or technology-based numerical values that establish concentrations or discharge limits for specific chemicals or classes of chemicals. If more than one requirement applies to a contaminant, compliance with the more stringent applicable ARAR is required. In the absence of ARARs, guidance values are considered.

All groundwater in New York State is classified as GA, groundwater suitable as a source of drinking water. Groundwater at the site is currently used as a source of drinking water. Therefore, New York State Groundwater Quality Standards are applicable requirements and the Federal and New York State primary drinking water standards are considered to be relevant and appropriate.

2.2.2.1.1 Federal Standards and Guidelines

<u>Federal Drinking Water Standards and Regulations</u>

- National Primary Drinking Water Standards (40 CFR 141). Drinking water standards (MCLs and non-zero maximum contaminant level goals [MCLGs]) for the site-related contaminants are provided in Table 2-1. Note that these MCLs are considered relevant and appropriate requirements for groundwater which is classified as suitable for drinking water (CERCLA Section 300.430[e][2][i][b]).

Federal Vapor Intrusion Guidance

- OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils

2.2.2.1.2 New York Standards and Guidelines

- New York State Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (6 NYCRR Part 703). Used as the primary basis (applicable ARAR) for setting numerical criteria for groundwater and surface water cleanups. The standards for the site-related contaminants in groundwater are included in Table 2-1.

- New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (TOGS 1.1.1). Provides groundwater criteria to be considered where there are no standards.

- NYSDOH Drinking Water Standards (10 NYCRR Part 5). Sets MCLs for public drinking water supplies. This is a relevant and appropriate ARAR for cleanup of the groundwater at the site. The standards for the site-related contaminants are included in Table 2-1.

2.2.2.2 Location-specific ARARs and TBCs

Location-specific ARARs are those which are applicable or relevant and appropriate due to the location of the site or area to be remediated; they are shown on Table 2-2. Possible applicable regulations at the site are relevant to historical places and archaeological significance.

2.2.2.2.1 Federal Standards and Guidelines

Cultural Resources

- National Historic Preservation Act (40 CFR 6.301)

Historic Preservation Standards and Regulations

- National Historic Preservation Act (40 CFR 6.301)

2.2.2.2.2 New York or Local Standards and Guidelines

No New York or local standards and guidelines are identified as location-specific ARARs or TBCs for this site.

2.2.2.3 Action-specific ARARs and TBCs

Action-specific ARARs are requirements which set controls and restrictions to particular remedial actions, technologies, or process options; they are shown on Table 2-3. These regulations do not define site cleanup levels but do affect the implementation of specific remedial technologies. For example, although outdoor air has not been identified in the RI report as a contaminated medium of concern, air quality ARARs are listed below, because some potential remedial actions may result in air emissions of toxic or hazardous substances. These action-specific ARARs are considered in the screening and evaluation of various technologies and process options in subsequent sections of this report.

2.2.2.3.1 Federal Standards and Guidelines

General - Site Remediation

- Occupational Safety and Health Administration (OSHA) Worker Protection (29 CFR 1904, 1910, 1926)
- Resource Conservation and Recovery Act (RCRA): Identification and Listing of Hazardous Waste (40 CFR 261); Standards Applicable to Generators of Hazardous Waste (40 CFR 262); Standards Applicable to Owners and Operators of Treatment, Storage, and Disposal Facilities (40 CFR 264)

Transportation of Hazardous Waste

- Hazardous Materials Transportation Regulations (49 CFR 107, 171, 172, 177, and 179)
- Federal Resource Conservation and Recovery Act - Standards Applicable to Transporters of Hazardous Waste (40 CFR 263).

Disposal of Hazardous Waste

- Federal Resource Conservation and Recovery Act - Land Disposal Restrictions (40 CFR 268).

Discharge of Groundwater

- Federal Clean Water Act - National Pollutant Discharge Elimination System (40 CFR 100 et seq.); Effluent Guidelines and Standards for the Point Source Category (40 CFR 414)
- Federal Safe Drinking Water Act - Underground Injection Control Program (40 CFR 144, 146)

Off-Gas Management

- Federal Clean Air Act - National Ambient Air Quality Standards (40 CFR 50); National Emission Standards for Hazardous Air Pollutants (40 CFR 61)
- Federal Directive - Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites (OSWER Directive 9355.0-28)

2.2.2.3.2 New York Standards and Guidelines

General (6 NYCRR)

- Environmental Remedial Program (Part 375) - General Remedial Program Requirements (Subpart 375.1) and Environmental Restoration Program (Subpart 375.4)
- Hazardous Waste Management System - General (Part 370.1)
- Identification and Listing of Hazardous Wastes (Part 371)

Transportation of Hazardous Waste (6 NYCRR)

- Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities (Part 372)
- Waste Transporter Permit Program (Part 364)

Disposal of Hazardous Waste (6 NYCRR)
- Standards for Universal Waste (Part 374-3)
- Land Disposal Restrictions (Part 376)

Discharge of Groundwater (6 NYCRR)
- The New York Pollutant Discharge Elimination System (NYPDES) (Part 750-757)
- New York State Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (6 NYCRR Part 703).
- New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (TOGS 1.1.1).

Off-Gas Management
- General Provisions (6 NYCRR Part 200)
- Permits and Certificates (6 NYCRR Part 201) - Exemptions and Trivial Activities (Subpart 201.3)
- Emissions Verification (6 NYCRR Part 202)
- General Prohibitions (6 NYCRR Part 211)
- General Process Emission Sources (6 NYCRR Part 212)
- New York Air Quality Standards (6 NYCRR Part 257)

Well Drilling Restrictions
- New York State DEC (6 NYCRR Part 602) Applications for Long Island Wells
- New York State DOH State Sanitary Code Appendix 5-B Standards for water wells

2.3 Preliminary Remediation Goals

Both federal and state chemical-specific ARARs were identified for groundwater. New York State groundwater quality standards are considered to be applicable for the remediation of groundwater contamination at the site. Federal and State primary drinking water regulations are considered to be relevant and appropriate for consideration in the remediation of the groundwater since the groundwater is currently used as a source of potable water.

The groundwater preliminary remediation goals for the site contaminants of concern, PCE, TCE, cis-1,2 DCE, and 1,1-DCE, are provided in Table 2-4. For this site, the PRGs are the groundwater MCLs.

There are no federal or state ARARs for soil vapor contamination with PCE and TCE. The OSWER Draft Guidance *Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* provided generic vapor screening levels. EPA will conduct indoor vapor sampling during the winter heating season at buildings potentially affected by vapor intrusion. EPA will develop PRGs for the vapor pathway separately, if warranted by the sampling to be conducted during the winter heating season.

2.3.1 Groundwater Contaminant Plume to be Remediated

The groundwater contaminant plume consists of PCE and TCE concentrations that exceed the MCLs of 5 µg/L, as shown in Figure 1-6 and 1-7. The contaminant plume for 1,1-DCE is within the TCE or PCE plume and, therefore, is not shown separately. The contaminant plume is mainly located in the Magothy aquifer. These plume maps represented the contaminant distribution found during the RI. Based on the sample results from the RI, the northern plume boundary is approximately at 100 Ring Road, and the southern boundary is in the vicinity of the two Garden City supply wells GWP-10 and GWP-11. The vertical extent of the contaminant plume at the north near SVP-2 is from approximately 55 feet bgs to more than 455 feet bgs. In the middle near SVP-4, the plume is from approximately 105 feet bgs to more than 425 feet bgs. At the two supply wells in the south-southwest corner of the site, contamination is as deep as 417 feet bgs. The bottom of the contaminant plume has not been defined because PCE and TCE concentrations exceeded the MCLs in samples collected from the lowest sampling ports at SVP-2 and SVP-4. However, contaminant levels in the lowest ports are considerably lower (e.g., TCE at approximately 20 µg/L) than groundwater from ports higher in the multiport well column.

2.4 General Response Actions

General response actions are broad categories of actions that might satisfy the RAOs and that characterize the range of remedial responses appropriate to the media of concern at the site. Following the development of general response actions, one or more remedial technologies and process options were identified for each general response action category. Although an individual response action might be capable of satisfying the RAOs alone, combinations of response actions are usually required to address site contamination adequately. General response actions applicable to groundwater remediation at this site are described below.

2.4.1 No Action

The NCP and CERCLA require the evaluation of a No Action alternative as a basis for comparison with other remedial alternatives. Under the No Action alternative, no remedial actions are implemented, the current status of the site remains unchanged, and no action would be taken to reduce the potential for exposure to contamination.

2.4.2 Institutional/Engineering Controls

Institutional/Engineering Controls typically are restrictions placed to minimize access (i.e, fencing) or future use of the site (i.e, well drilling restrictions). These limited measures are implemented to provide some protection of human health and the environment from exposure to site contaminants. Long-term monitoring, which includes sampling and sample analysis, is usually used with Institutional/ Engineering Controls. Long-term monitoring provides information on contaminant migration and concentration changes. Institutional/Engineering Controls are generally used in conjunction with other remedial technologies; alone they are not effective in preventing contaminant migration or reducing contamination.

2.4.3 Monitored Natural Attenuation

Monitored natural attenuation (MNA) refers to the remedial action that relies on naturally occurring attenuation processes to achieve site-specific remediation goals within a reasonable time frame. Natural attenuation processes that reduce contaminant concentrations in groundwater include destructive (biodegradation and chemical reactions with other subsurface constituents) and nondestructive mechanisms (dilution, dispersion, volatilization, and adsorption). Biodegradation is generally the most significant destructive attenuation mechanism. Extensive modeling and monitoring are typically performed as part of the MNA response action to demonstrate that contaminants do not represent significant risk and that degradation is occurring. Review of site data suggests that anaerobic biodegradation, generally the most significant degradation mechanism for PCE and TCE, is not occurring to a significant extent at this site. However, natural attenuation through nondestructive mechanisms (dilution, dispersion, volatilization, and adsorption) would be expected to occur within the aquifers.

2.4.4 Containment

Containment actions use physical or low permeability barriers to minimize or eliminate contaminant migration. Containment technologies do not involve treatment to reduce the toxicity or volume of contaminants. The response actions require long-term monitoring to determine whether containment actions are performing successfully. The NCP does not prefer containment response actions since they do not provide permanent remedies. The contamination at the site extends to more than 400 feet bgs. Containment technologies would not be implementable at this site due to the significant depth of contamination.

2.4.5 Groundwater Extraction

Groundwater extraction can provide hydraulic control to prevent migration of dissolved contaminants. Groundwater extraction is usually used in conjunction with other technologies, such as treatment or discharge options, to achieve the RAOs for the removed media. The extraction response action does not reduce the concentrations of contaminants in groundwater. It merely transfers the contaminants to be managed under another response action.

2.4.6 Treatment

Treatment involves the destruction of contaminants in the affected media, transfer of contaminants from one media to another, or alteration of the contaminants, thereby making them innocuous. The result is a reduction in toxicity/mobility/volume (T/M/V) of the contaminants. Treatment technologies vary among environmental media and can consist of chemical, physical, thermal, and biological processes. Treatment can occur in place or above ground. This GRA is usually preferred unless site- or contaminant-specific characteristics make it infeasible from an engineering or implementation perspective, or too costly.

2.4.7 Discharge

Discharge response actions for groundwater involve the discharge of extracted and treated groundwater via on-site injection, on-site surface recharge, or surface water discharge. Discharged water must meet regulatory discharge requirements.

2.5 Identification and Screening of Remedial Technologies and Process Options

For each GRA there are various remediation methods, or technologies, used to carry out the response action. The term technology refers to general categories of technology types. Each technology may have several process options, which refer to the specific material, equipment, or method used to implement a technology. For example, the technology category of physical treatment for groundwater may include process options such as air stripping and carbon adsorption. These technologies describe broad categories used in remedial action alternatives, but do not address details, such as performance data, associated with specific process options.

The technology screening approach is based upon the procedures outlined in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). This evaluation process uses three criteria: Effectiveness, Implementability, and Relative Cost. Among these three, the effectiveness criterion outweighs the implementability and relative cost criteria. These criteria are described below:

- Effectiveness - This evaluation criterion focuses on: 1) the effectiveness in extracting, treating and/or handling by other means (e.g., in situ treatment or natural attenuation) the estimated volume of contaminated groundwater, and the ability to meet the remediation goals; 2) the potential impacts to human health and the environment during the construction and implementation phases; and 3) how proven and reliable the process options are expected to be with respect to the contaminants and conditions at the site.

- Implementability - This evaluation criterion includes: 1) the technical and administrative feasibility of implementing the remedial system components; and 2) the amount of space needed for treatment and disposal facilities, piping and discharge runs, the availability of space, accessibility, and available vendors.

- Relative Cost - Cost plays a limited role in the screening process. Both capital and operation and maintenance (O&M) costs are considered. The cost analysis is based on engineering judgement, and each process is evaluated as to whether costs are low, moderate, or high relative to the other options within the same technology type.

All remedial technologies (both screened out and retained) are briefly described in Table 2-5. Remedial technologies and process options that were retained will be used for the development of alternatives. Only remedial technologies or process options that could achieve the RAOs, either alone or in combination with other technologies and process options, were retained and discussed below.

2.5.1 No Action

The No Action alternative is not a technology. The NCP requires that a No Action alternative be considered as a basis for comparison. No remedial actions would be implemented. The contaminants have reached the two Garden City supply wells GWP-10 and GWP-11 downgradient from the site for many years. The extracted groundwater is treated with air strippers and disinfection units before being discharged into the Garden City water system. Under No Action, the two supply wells would be operated according to the village's water consumption needs.

Effectiveness - The No Action alternative is used as a baseline against which other technologies may be compared. It generally does not provide measures that would comply with ARARs, or otherwise meet RAOs. It does not prevent human exposure to contaminated groundwater. The contaminated groundwater does not pose human health risks because the contaminants are removed from the groundwater extracted by the Garden City supply wells GWP-10 and 11 before entering the Village water distribution system.

Implementability - The No Action alternative is implementable given there is no action required.

Relative Cost - The No Action alternative involves no capital or O&M costs.

2.5.2 Institutional Controls

Institutional controls do not reduce the toxicity, mobility, and volume of contamination, but can be implemented to reduce the probability of exposure to contaminated groundwater. Institutional controls consist of administrative actions which control the use of the site. Institutional controls generally require long-term monitoring of contaminant concentrations. Typical institutional controls are discussed below.

2.5.2.1 Deed Restrictions and Well Drilling Restrictions

Deed restrictions and well drilling restrictions are regulatory actions which prevent certain types of uses for areas with contamination. Restrictions on installation of wells within the contaminant plume would eliminate direct exposure (e.g., dermal, ingestion, or inhalation) to contaminated groundwater, thus preventing unacceptable human health risk. In addition, deed restrictions may be also be used to limit areas of new construction and restrict building types.

Effectiveness - Deed restrictions and well drilling restrictions may effectively restrict future site uses or activities that may result in direct contact with contaminated groundwater. The effectiveness of deed restrictions and well drilling restrictions is dependent on proper enforcement. Deed restrictions and well drilling restrictions, however, would not reduce the migration and the associated environmental impact of the groundwater.

Implementability - Deed restrictions and well drilling restrictions would be implemented through the current administrative system. Deed restrictions need to be developed among different governmental agencies to limit the current and future land use options as long as the contamination exists at unacceptable levels. Deed restrictions and well drilling restrictions may also be used in addition to remediation activities, as a protective measure to prevent exposure to contaminants during remediation.

Relative Cost - Deed restrictions and well drilling restrictions have low administration costs.

2.5.2.2 Long-term Monitoring

Long-term monitoring includes periodic sampling and analysis of groundwater samples. This program would provide an indication of the movement of the contaminants or the progress of remedial activities.

Effectiveness - Long-term monitoring alone would not be effective in reducing contamination levels. It would not alter the risk to human health. Long-term monitoring would be effective in providing information on site conditions to decision makers.

Implementability - Groundwater monitoring can be implemented using the existing monitoring well network. It is a proven and reliable process, and could be easily implemented. All monitoring wells are easily accessible for sample collection.

Relative Cost - Long-term monitoring has low capital costs to establish the sampling work plan and procedures, and medium O&M costs.

2.5.3 Groundwater Extraction

Groundwater extraction can be implemented to establish hydraulic control of the plume and to prevent further migration of contaminants. Extracted groundwater would be treated through ex-situ treatment and then discharged. Groundwater extraction can be accomplished by using extraction trenches or extraction wells as discussed in Table 2-5. Groundwater extraction wells are applicable for this site.

2.5.3.1 Groundwater Extraction Wells

This technology involves installation of groundwater extraction wells within areas of interest to provide hydraulic control of the plume. Aquifer pumping tests would be required to understand the site-specific hydrogeology. Groundwater modeling is often conducted to simulate the capture zones of extraction wells and to optimize the number, locations, and pumping rates of extraction wells.

Effectiveness - This conventional technology is effective in providing hydraulic control for sites where the hydrogeology is well understood and the pumping rate necessary to maintain hydraulic control is sustainable.

Implementability - Extraction wells are implementable. The equipment and materials are readily available.

Relative Cost - Extraction wells have medium capital cost and medium O&M costs.

2.5.4 Ex-Situ Treatment Technologies

If groundwater extraction is selected as a remediation option, an ex-situ treatment system would be required to remove contaminants from the extracted groundwater before discharging on site. The primary advantage of ex-situ treatment over in-situ treatment is better process control (i.e., the ability to monitor and continuously mix the groundwater) which results in more uniform and effective treatment. Several ex-situ treatment technologies were identified as potentially applicable at the site. These technologies, discussed below, are separated into aqueous phase treatment and vapor-phase treatment/discharge.

2.5.4.1 Precipitation and Filtration

Precipitation and filtration is a process in which suspended solids are removed from the influent. Precipitation can be enhanced with the addition of chemicals and filtration can be accomplished with disposable bag filters. The disposable filters are available in various opening sizes. The filter size is selected according to the influent suspended solids content, particle size distribution, and the effluent discharge requirements for suspended solids.

Effectiveness - This process reduces the level of maintenance required for the operation of a treatment system (e.g., air stripper, carbon adsorption unit) by preventing accumulation of solids within the trays, sumps, and other components of the treatment system. It also reduces the amount of suspended solids discharged in the effluent, which must conform with New York Regulations on State Pollution Discharge Elimination System (SPDES) discharge criteria.

Implementability - This technology is easily implementable. The equipment and material are readily available.

Relative Cost - Precipitation and filtration have medium capital cost and medium O&M cost.

2.5.4.2 Air Stripping

Air stripping is a physical mass transfer process that uses clean air to remove dissolved VOCs from water by increasing the surface area of the groundwater exposed to air. Commonly used systems include the countercurrent packed column, multiple chamber fine bubble aeration systems, and low profile sieve tray air strippers. In a countercurrent packed column, contaminated groundwater is sprayed through nozzles at the top of the column, then flows downward through packing materials. In a low profile sieve tray air stripper, contaminated groundwater flows across the surface of a series of perforated trays. In both systems, clean air is forced into the system by a blower in a direction opposite to groundwater flow (i.e., from the bottom, flowing upward). In a multiple chamber fine bubble aeration system, contaminated groundwater flows through aeration tank chambers, and air is introduced at the bottom of each chamber through diffusers forming thousands of fine bubbles. As the fine air bubbles travel upward through the water, mass transfer occurs at the bubble/water interface. System efficiency increases with decreasing bubble diameter.

In general, the water stream out of an air stripper can be discharged to surface water or groundwater. The off gas may require additional treatment (e.g., carbon adsorption) before discharge to the atmosphere.

Effectiveness - Air stripping is effective in removing volatile contaminants from water. Air stripping is proven to successfully remove TCE and PCE from water because of their high Henry's law constants. Therefore, air stripping is an applicable treatment option for this site.

Implementability - This technology is implementable. The equipments and materials are readily available.

Relative Cost - Air-stripping involves medium capital and medium O&M costs.

2.5.4.3 Liquid-Phase Activated Carbon Adsorption

Carbon adsorption can be used to treat contaminated groundwater directly. Contaminated groundwater can be pumped through vessel(s) containing granular activated carbon (GAC) to which contaminants are adsorbed and are, thereby, removed from the groundwater. When the concentration of contaminants in the effluent exceeds a pre-established value (breakthrough concentration), the GAC is removed for regeneration or disposal.

Effectiveness - Carbon adsorption is effective in removing contaminants with moderate or high organic carbon partition coefficients (K_{oc}) from groundwater. Carbon adsorption is not effective in removing vinyl chloride (VC), a degradation product of TCE and PCE. However, no VC has been detected at the site during any sampling activity, including the RI. The process is susceptible to biological and inorganic fouling and may require pretreatment steps such as pH adjustment and suspended solids removal.

Implementability - Activated carbon adsorption is implementable and a proven technology. The equipment and materials are readily available.

Relative Costs - This technology involves medium capital and medium O&M costs.

2.5.4.4 Vapor-Phase Activated Carbon Adsorption
Carbon adsorption can be used to treat the off-gas generated during air stripping. Contaminants in the vapor phase of the off-gas are adsorbed onto GAC, and removed from the waste stream.

Effectiveness - Activated carbon adsorption is effective in removing PCE, TCE and DCE. It is not effective in the removal of VC; an additional treatment method such as potassium permanganate oxidation would be required for sites with significant concentrations of VC. At this site, no VC has been detected in any samples. This additional treatment is not anticipated to be needed.

Implementability - This technology is implementable and proven, and the equipment and materials are readily available.

Relative Cost - This technology involves medium capital and medium O&M costs.

2.5.5 In-Situ Treatment Technologies
In-situ treatment technologies including phytoremediation, in-situ chemical oxidation, permeable reactive barriers, groundwater circulation wells, air sparging with soil vapor extraction, and enhanced anaerobic bioremediaiton are evaluated in Table 2-5. Due to the huge size of the contaminant plume, the heterogeneous nature of the subsurface soils, and the fact that continued contamination sources were not found, none of the in-situ technologies are applicable for the site.

2.5.6 Discharge
Once groundwater has been treated, it can be disposed on-site or off-site. Potential on-site and off-site disposal options for groundwater are evaluated and shown in Table 2-5. The retained options are described below.

2.5.6.1 On-site Injection
the on-site injection technology involves injecting treated groundwater to the subsurface using a series of wells. Injection requires that the groundwater be treated to meet applicable groundwater standards prior to discharge to the subsurface.

Effectiveness - The effectiveness of this option would rely on the subsurface geology and proper injection well design and construction, including adequate pipe sizing, proper placement of the wells, and reliable construction materials. At this site, the sandy soil has very high permeability, and on-site injection can be an effective discharge option.

Implementability - The option to discharge treated effluent to a series of injection wells would be easily and readily implementable, given that standard construction methods and materials would be utilized. The land space requirement is minimal. The subsurface at this location is also suitable for the installation of injection wells for discharge to the shallow or intermediate aquifers. Some implementability problems can arise during long-term operation of injection wells, such as clogging of screen packs with precipitates or microbial fouling, particularly in high iron conditions. These can be overcome by periodic chlorination of the injected water, and redevelopment and cycling on/off of wells.

Relative Cost - This technology involves medium capital and medium O&M costs.

2.5.6.2 On-site Surface Recharge

Treated groundwater can be disposed on site using a surface recharge system which consists of an excavated recharge basin, an infiltration gallery, or a leaching basin. Recharge basins are shallow ponds that allow water to infiltrate into the ground gradually, and, depending on the permeability of the soil, generally require large surface areas. As with injection wells, on-site surface recharge requires that the extracted groundwater be treated to meet applicable groundwater standards prior to discharge to the subsurface. Two recharge basins (Pembrook and Nassau County #124) are located south of the site and were used previously for cooling water discharge. They could be used for the discharge of effluent water.

Effectiveness - The effectiveness of this option would rely on the proper construction of the recharge system, including adequate sizing and use of suitable sand and gravel. The surface area required depends on the extraction rates and types of facilities.

Implementability - This discharge option is readily implementable, as standard construction methods and materials would be utilized. Currently, there are two recharge basins on or near the site that can potentially be used for groundwater discharge.

Relative cost - This technology involves low capital and low O&M costs.

3

Section Three

Section 3
Development and Screening of Remedial Action Alternatives

The objective of this section is to describe possible remedial action alternatives for the contaminated groundwater found at the Old Roosevelt Field site under its current conditions as described in the RI. To address the site-specific RAOs, alternatives were created by combining technologies and process options retained in Section 2.

3.1 Development of Remedial Action Alternatives

The technologies and process options retained include the following:

- No action
- Institutional controls
- Groundwater Extraction
- Ex-situ treatment, including air stripping, liquid phase and gas phase carbon adsorption
- Discharge of treated water, including on-site injection and on-site surface recharge

To develop remedial alternatives for the site, representative process options were selected from the same groups of remedial technologies, as appropriate. However, each process option may still be applicable and should be considered during final remedial design. These five technologies were combined into three alternatives. The alternatives are:

- Alternative 1 - No Action
- Alternative 2 - Monitoring
- Alternative 3 - Groundwater Extraction and Ex-situ Treatment (Pump and Treat)

The No Action alternative was retained in accordance with the NCP requirement to serve as a baseline for comparison with the other alternatives. Alternatives 2 and 3 were developed under the current site conditions as described in Section 3.1.1. Both alternatives were developed with the intent not to impact the pumping capacity of Garden City supply wells GWP-10 and GWP-11. Although it is highly unlikely that Garden City would reduce the pumping rate or shut down these two supply wells, a contingency plan was developed, should reduced pumping or shut down occur. The contingency plan is briefly described in Section 3.1.5.

As part of this FS, a preliminary three-dimensional groundwater model was used to simulate the capture zones of different groundwater extraction scenarios and to assist in estimating the clean up time for different alternatives.

3.1.1 Current Conditions

The two Garden City supply wells GWP-10 and GWP-11 are located at the southern portion of the contaminant plume. The extracted groundwater is treated with air strippers and disinfection units before discharge into the village water system. These two wells operate alternatively and intermittently based on the consumption rate. They are usually pumped at their design capacity. The daily operation duration is longer during high water consumption periods than during low water consumption periods. The monthly total pumping rates during the summer months are typically twice those of the winter months because of higher water consumption during the summer months.

Overall, these two wells provide approximately 20 percent of the drinking water supply for the village. The total pumpage is not expected to be reduced in the future. Therefore, any remedial actions were designed so they would not impact the operation of the two supply wells.

In this FS, future pumping at the two supply wells is assumed to be similar to the pumping between 2001 and 2005. Monthly pumping rates between 2001 and 2005 were used to simulate future pumping conditions over time of these two wells in the preliminary groundwater model, so as to account for both seasonal and yearly variations.

3.1.2 Alternative 1 - No Action

In accordance with NCP requirements, the No Action alternative provides a baseline for comparison with the other alternatives. Under this alternative, no further action would be implemented by EPA in order to reduce the groundwater contamination levels or to prevent human exposure to contaminated groundwater. In addition, no groundwater monitoring would be conducted to monitor changes in the contaminant plume. The current operations at the two supply wells would continue and be maintained by Garden City.

3.1.3 Alternative 2 - Monitoring

Under the Monitoring Alternative, long-term monitoring and institutional controls would be implemented to reduce human exposure to contaminated groundwater. The results of long-term monitoring would be used to evaluate the migration and changes in the contaminant plume over time. This alternative would also include future vapor intrusion sampling at six commercial buildings in the mall area to determine if site-related vapors are migrating into the buildings.

3.1.4 Alternative 3 - Groundwater Extraction and Ex-situ Treatment (Pump and Treat)

Under the Pump and Treat Alternative, new groundwater extraction well(s) would be installed to prevent further migration of the contaminant plume. The proposed location and configuration of the new well(s) would be determined after the preliminary groundwater model is updated and refined. Two possible locations would be evaluated: one is downgradient of SVP-4 and the other is in the vicinity of supply wells GWP-10 and GWP-11. New extraction well(s) downgradient of SVP-4 would capture the contaminated groundwater with high concentrations before they reach wells GWP-10 and GWP-11, so that the overall cleanup time would be shortened. This new well(s) would be placed at a distance so as not to impact the pumping capacity of supply wells GWP-10 and GWP-11, but still attain the most efficient cleanup time. A new extraction well(s) in the vicinity of GWP-10 and GWP-11 would only be needed if the groundwater model indicates that contaminants from the site at their current levels would migrate in a downgradient direction past the two supply wells.

Contaminated groundwater extracted from the new extraction well(s) would be treated using a newly installed ex-situ treatment system with air-stripper and/or carbon adsorption units. The treated groundwater would be discharged to the local recharge basin or reinjected into the Magothy aquifer.

The duration of the pump and treat system to remediate the plume and a life-cycle cost of this alternative will be estimated.

3.1.5 Contingency Plan

In the event that Garden City shuts down supply wells GWP-10 and GWP-11, or significantly reduces their pumping rates, site-related contaminants would begin to migrate further downgradient. Historically, the Garden City supply wells have been off line for extended periods of time due to groundwater contamination. As a preventive measure, a contingency plan has been developed. The contingency plan includes extraction well(s) and an ex-situ treatment system located in the vicinity of supply wells GWP-10 and GWP-11 to prevent downgradient migration of contamination. The contingency plan would only be implemented if the supply wells shut down or if the pumping rates are severely reduced. EPA would request that the Village of Garden City provide two-years advance notice before the wells are shut down or the pumping rates are significantly reduced. In this FS, the preliminary groundwater model was used to determine the location and configuration of the contingency extraction well(s). Treated groundwater would be discharged to the nearby Nassau County recharge basin, re-injected into the Magothy aquifer, or both, if necessary.

3.2 Screening of Remedial Action Alternatives

Since only a limited number of remedial alternatives were developed, all three alternatives will be carried forward through the detailed description and evaluation in Section 4 and Section 5. Screening of remedial action alternatives will not be performed.

4

Section Four

Section 4
Detailed Description of Remedial Action Alternatives

Three remedial action alternatives, developed in Section 3, are applicable to the contaminated groundwater at the site.

Alternative 1 - No Action
Alternative 2 - Monitoring
Alternative 3 - Groundwater Extraction and Ex-situ Treatment (Pump and Treat)

In addition, since all the alternatives, except No Action, were developed based on the assumption that the two Garden City supply wells would be in operation at their current schedule in the future, a contingency plan was developed in case these two wells are shut down or experience significant reduction in pumping rates. Section 4.4 discusses the contingency plan.

4.1 No Action

The No Action alternative, as required by the NCP, was retained for comparison purposes. Under this alternative, no further action would be implemented by EPA in order to reduce the groundwater contamination levels or to prevent human exposure to contaminated groundwater. In addition, no groundwater monitoring would be conducted to evaluate changes in the contaminant plume.

4.2 Monitoring

The Monitoring alternative includes:

- Long-term monitoring
- Institutional controls
- Soil vapor sampling
- Five-year review

<u>Long-term Monitoring</u>
Long-term monitoring program would involve annual groundwater sample collection and analysis from nine monitoring wells, two supply wells, and annual groundwater sampling reports. The 11 wells are SVP-2 to SVP-8, GWX-10019, GWX-10020, GWP-10, and GWP-11. The results from the long-term monitoring program would be used to evaluate the migration and changes in the contaminant plume over time. If the results show reduction of the size of the plume in the future, the long-term monitoring program could be modified accordingly.

<u>Institutional Controls</u>
institutional controls would restrict the future use of groundwater at the site. Specifically, the New York State Department of Health State Sanitary Code regulates installation of private potable water supply wells in Nassau County. In addition, EPA would rely on the current zoning in the area including and surrounding the mall to

restrict the land use to commercial industrial uses. If a change in land use is proposed, additional investigation of soils in this area would be necessary to support the land use change.

Soil Vapor Sampling
There is concern that site-related vapor may migrate into the commercial buildings in the western mall area. Vapor intrusion sampling would be conducted at six buildings during the winter heating season.

Site Management Plan
A site management plan (SMP) would also be developed and would provide for the proper management of all site remedy components post-construction, such as institutional controls, and shall also include: (a) monitoring of site groundwater to ensure that, following remedy implementation, the groundwater quality improves; (b) conducting an evaluation of the potential for vapor intrusion, and mitigation, if necessary, in the event of future construction; (c) provision for any operation and maintenance required of the components of the remedy; and (d) periodic certifications by the owner/operator or other person implementing the remedy that any institutional and engineering controls are in place.

Five-Year Review
Because MCLs will take longer than five years to achieve, a review of site conditions will be conducted no less often than once every five years.

Duration of this Alternative
The duration of this alternative is estimated using the preliminary groundwater model. The plume maps and the cross sections (Figures 1-6 and 1-7) were used to develop the three-dimensional PCE and TCE plume in the model. Monthly pumping records from 2001 to 2005 for the two Garden City supply wells and all other surrounding supply wells were used in the model simulations. These pumping data represent the actual pumping conditions, and, therefore, account for the seasonal and yearly variations in water consumption in the Village. The model also simulated a range of effective porosities as a sensitivity test. An effective porosity of 15 percent (0.15) is considered to be the representative porosity for the Magothy aquifer at the site. Therefore, only modeling results with an effective porosity of 0.15 are used in this FS. Modeling results with other effective porosities are presented in Appendix A.

The preliminary modeling results predicted it would take 29 years and 46 years for TCE and PCE, respectively, to be reduced to the MCLs in the aquifer (see Appendix A).

The preliminary groundwater model also indicated that a small portion of the contaminant plume may migrate downgradient. One possible cause was the low pumping rate of 2001 used in the model simulation. If future pumping rates at supply wells GWP-10 and GWP-11 were not less than their 2005 level, the contaminant plume identified during the RI would not migrate downgradient (see Appendix A).

4.3 Groundwater Extraction and Ex-Situ Treatment (Pump and Treat)

The pump and treat alternative includes:

- Evaluation and upgrade of air strippers at supply wells GWP-10 and GWP-11
- Pre-design investigation of the contaminant plume
- Groundwater modeling
- Stage II cultural resource survey (if remedial activities impact sensitive areas)
- Groundwater extraction well(s)
- Ex-situ treatment system
- Discharge of treated groundwater
- Institutional controls
- Long-term monitoring
- Soil vapor sampling
- Five-year review

<u>Evaluation and Upgrade of the Air Strippers at supply wells GWP-10 and GWP-11</u>
The two packed tower air strippers at the supply wells were installed in 1987, and have been in operation for approximately 20 years. During the years of operation, the Village has upgraded the stripper capacity several times. An evaluation of the conditions of the air strippers would be conducted. Any necessary upgrade or replacement of the air strippers would be proposed. The upgrade or replacement costs of the air strippers would be estimated.

<u>Pre-Design Investigation of the Contaminant Plume</u>
A pre-design investigation would be conducted to collect information for remedial design. The pre-design investigation for this alternative would include: installation of three multiport monitoring wells; pumping test; literature review; and infiltration tests at the recharge basin.

The northern boundary and the vertical extent of the contaminant plume would be refined at SVP-2 and SVP-4. SVP-9 would be installed to the north of well GWX-9953 to confirm the northern boundary of the plume. SVP-10 would be installed to the west of well GWX-10019 to confirm the total depth, the contaminant levels, and the vertical distribution of the contaminant plume at this area. SVP-11 would be installed to the south of the two supply wells GWP-10 and GWP-11 to monitor whether contaminants are migrating downgradient from the Old Roosevelt Field area (see Figure 4-1). The new multiport monitoring wells would be installed 40 feet deeper than SVP-4. The installation of the three new wells would be similar to the multiport monitoring well installation during the RI. In addition, gamma logs would be run in all new wells to determine lithology.

A pumping test would be conducted to improve the accuracy of the groundwater model. The new extraction well would be used to obtain site-specific hydraulic conductivity. A literature review would be conducted to obtain all available lithology logs of existing wells near the site. The lithology data obtained from this review and the pre-design investigation gamma logs at the new multiport wells would be used to further refine the groundwater model's site-specific conditions.

Infiltration tests would also be conducted at the Nassau County recharge basin #124 to obtain information on its current capacity in order to calibrate the groundwater model.

Groundwater Modeling

The preliminary three-dimensional groundwater model used in this FS would be updated for the remedial design. Up to date contaminant distribution data would be collected from the pre-design investigation, and used to update the contaminant plume maps. The lithology and site-specific hydraulic conductivity obtained during literature review and the pumping test would be incorporated into the model. Nassau County conducted a round of synoptic water level measurements in 2006; however, since 2006 pumping data from water districts surrounding the site were not available during the FS modeling, the model could not be calibrated using the 2006 water level data. During the remedial design, the most recent available pumping data and water level data would be used and the model would be re-calibrated accordingly.

The improved groundwater model with up-to-date contaminant plumes would be used to select the final location(s) of groundwater extraction well(s) and discharge options for treated groundwater for the remedial design.

Stage II Cultural Resource Survey

If ground intrusion such as well drilling or pipe routing are planned in any areas specified as sensitive for archeological resources during the Stage 1A cultural resource survey, a Stage II survey would be conducted.

Groundwater Extraction Well

To reduce the contaminant concentrations reaching the two supply wells GWP-10 and GWP-11, a groundwater extraction well(s) would be installed south of SVP-4 as shown in Figure 4-2. Remedial extraction well SVP-4E would capture the contaminant plume upgradient of this well including the 200 μg/L PCE plume, while ensuring that the pumping capacity of supply wells GWP-10 and GWP-11 is not affected. The final location and number of extraction wells required would be determined after the pre-design investigation is completed and the groundwater model is updated.

The location, screen interval, and pumping rate of SVP-4E were estimated using the preliminary groundwater model. The proposed pumping rate is 150 gpm with the screened interval from 175 to 275 below msl. The preliminary groundwater model indicated that after 10 years of pumping at SVP-4E, most of the contaminant plume upgradient of this extraction well would be removed. A very small portion of the contaminant plume near SVP-4E would still have concentrations above the MCLs. However, continuous operation of SVP-4E after 10 years was not recommended in the model, because it would not improve the overall cleanup time of the entire plume.
As the preliminary groundwater model indicated, the drawdown caused by operation of both the new extraction well (SVP-4E) and the supply wells GWP-10 and GWP-11

would create a low flow zone between the two pumping areas, as shown on Figure 4-3. To the north of this low flow zone, groundwater flows toward SVP-4E; to the south of this low flow zone, groundwater flows toward the two supply wells. However, contaminants within the low flow zone would be held in place until extraction well SVP-4E is shut down. Once the extraction well SVP-4E is shut down, the low flow zone would disappear.

To minimize the low flow zone and to obtain a cost effective alternative, several model simulations were conducted. Simulations include: a) one extraction well sequentially at different locations, b) three extraction wells running simultaneously at a lower flow rate and perpendicular to the groundwater flow, and c) three extraction wells running simultaneously at a lower flow rate and parallel to the groundwater flow. The results indicated that in order to capture the contaminant plume upgradient of the extraction wells, it is difficult to avoid creating a low flow zone. The layout shown in Figure 4-3 is a cost effective alternative for the current contaminant plume under the current model assumptions. For costing purposes in the FS, one extraction well was assumed.

<u>Ex-Situ Groundwater Treatment</u>

Precipitation, filtration, air-stripping, liquid phase carbon adsorption, and vapor-phase carbon adsorption are process options retained for ex-situ treatment of extracted contaminated groundwater. Precipitation and/or filtration are not considered necessary because groundwater at the site generally has low concentrations of iron and manganese. During the RI, metal analyses were performed for one sample taken from each monitoring well. Iron and manganese results are shown in Table 4-1. In general, iron concentrations ranged from 46 to 178 µg/L at the mall area. Although iron concentrations in GWX-10019 and GWX-10020 were elevated and ranged from 1.63 to 5.14 milligrams per liter (mg/L), these levels are likely to be localized considering the iron concentrations detected elsewhere and the fact that no filtration system is required at supply wells GWP-10 and GWP-11. In addition, GWX-10019 and GWX-10020 are not within the capture zone of the new extraction well SVP-4E, so the elevated iron and manganese concentrations in these two wells is unlikely to impact the groundwater quality at the new extraction well.

Under this alternative, a low profile air stripper was selected as the representative process option to remove the VOC contaminants. Liquid phase activated carbon units were also considered; however, due to the costs associated with carbon use and disposal, and frequent maintenance needs, it was not selected as the representative process option in this FS. During the remedial design, other treatment technologies (including liquid phase carbon adsorption) would be considered as more information becomes available. The treated water should conform to the groundwater and surface water discharge standards.

Based on the maximum concentrations of PCE and TCE detected in SVP-4 during the RI, the maximum total VOCs (PCE and TCE) generated in the off-gas from the air stripper would be 1.5 pounds per day (lbs/day). According to the OSWER Directive 9355.0-28, *Control of Air Emissions from Superfund Air Strippers and Superfund Sites* (EPA 1989), off-gas treatment would not be necessary since the total VOC emissions are below 15 lbs/day. For New York State, according to air emission regulation 6NYCRR part 212, the off-gas treatment required for VOC emission less than 1 pound per hour (lb/hr) is determined by the commissioner on a case by case basis. The emission rate at this site is significantly below 1 lb/hr. In addition, air-stripper emissions from groundwater remediation activities are considered trivial by the State and do not require an application for an air permit.

The proposed location of the ex-situ treatment system is shown in Figure 4-2.

Discharge of Treated Groundwater
The treated groundwater would be discharged to the local Nassau County recharge basin #124. The basin was constructed in 1940 and was designed for an estimated tributary area of 162 acres. The estimated available capacity is approximately 1,124,960 cubic feet. This basin has a 36-inch overflow pipe located in the southeast corner. The overflow eventually leads to Hempstead Lake and ultimately to tidal waters. With a 150 gpm discharge rate from the groundwater extraction well SVP-4E, the daily loading to the recharge basin would be 28,944 cubic feet, significantly lower than the basin's capacity. However, during a storm event, the run-off would reduce the available capacity of the basin for groundwater discharge. During the remedial design, results of the infiltration tests would be used to calculate the capacity of the recharge basin. Run-off from a representative rain event would also be calculated to verify the available capacity for treated groundwater discharge.

Institutional Controls
See institutional controls under Alternative 2, Section 4.2.

Long-term Monitoring
The contaminant plume would be monitored through annual sampling and analysis of groundwater. The results of the long-term monitoring program would be used to evaluate changes in the contaminant plume over time and to ensure achievement of MCLs. For costing purposes, a total of 14 monitoring wells would be included in the long-term monitoring program, including the same wells identified in Alternative 2 and the three new multiport monitoring wells, SVP-9, SVP-10, and SVP-11 discussed in the pre-design investigation. Each new multiport monitoring well was assumed to have 10 sampling ports.

Soil Vapor Sampling
See soil vapor sampling under Alternative 2, Section 4.2.

Five Year Review
See five year review under Alternative 2, Section 4.2.

Site Management Plan
See SMP under Alternative 2, Section 4.2.

Duration of this Alternative
As discussed above, the extraction well SVP-4E would be operated for 10 years, at which time it is estimated that contaminant levels in the majority zone of influence upgradient of the new pumping well would approach or achieve the MCLs, and the contamination in the extracted groundwater at SVP-4E would have reached the MCLs. It is also noted that at the end of the same 10-year period, the contamination in extracted groundwater in supply wells GWP-10 and 11 would, before wellhead treatment, be below the MCLs. The preliminary groundwater model indicated that after SVP-4E is shut down, it would take another 25 years for the PCE and TCE contaminant residuals in the aquifer to meet the MCLs, with the residual contamination in the area south of the two supply wells, but within the capture zone of these wells. The overall duration for this alternative is estimated to be 35 years.

4.4 Contingency Plan

If for any reason supply wells GWP-10 and GWP-11 need to be shut down or experience significant reduction of pumping rates, a contingency plan would be implemented to prevent downgradient migration of contaminants. EPA would request the Village to provide advance notice (more than 2 years) to EPA so the contingency plan could be implemented in a timely manner, including design and construction of the extraction well, injection wells, treatment facility, treatment system, and pump-and-treat system start up.

The contingency extraction well would be designed to capture the entire contaminant plume and would operate continuously. The proposed location of the contingency extraction well was determined by the preliminary groundwater model, as shown in Figure 4-4. Based on the preliminary groundwater model results, the pumping rate would be 500 gpm with a screen interval from 285 to 325 feet below msl.

A new ex-situ treatment system would be installed unless the existing air-strippers at the two Garden City supply wells could be used to treat the extracted groundwater. For cost estimating purposes, the new ex-situ treatment system would include a low profile air stripper. A portion of the treated water, 300 gpm, would be reinjected in an upgradient area into the Magothy aquifer using two injection wells screened between 200 and 300 feet below msl. The rest of the treated water, 200 gpm, would be discharged to the nearby Nassau County recharge basin #124.

The operation of this contingency extraction well would be required until the contaminant levels are reduced to the MCLs. Without knowing when the contingency plan would be initiated, the duration cannot be estimated.

5

Section Five

Section 5
Detailed Analysis of Remedial Action Alternatives

In this section, the alternatives that were described in detail in Section 4 are evaluated using the evaluation criteria described in Section 5.1. The detailed analysis of each alternative is presented in Section 5.2, and a comparison of the alternatives is presented in Section 5.3.

5.1 Evaluation Criteria

In the NCP, EPA has outlined nine evaluation criteria to assess remedial alternatives which take into consideration the statutory requirements specified in Section 121 of CERCLA as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). In addition, EPA has issued guidance on the evaluation criteria in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA 1988). The criteria are classified into the following three groups:

Threshold Criteria. Threshold criteria are requirements that each alternative must meet in order to be eligible for selection.

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Primary Balancing Criteria. These criteria are used to distinguish the relative effectiveness of each alternative so that decision makers can evaluate the strengths and weaknesses of each alternative.

- Long-term Effectiveness and Permanence
- Reduction of Toxicity/Mobility/Volume (T/M/V) Through Treatment
- Short-term Effectiveness
- Implementability
- Cost

Modifying Criteria. These factors are typically considered following review of this document and the Proposed Plan by the regulatory agencies and the public, and are formally documented as part of the ROD. These criteria are not evaluated in this FS.

- Support Agency (State) Acceptance
- Community Acceptance

Brief discussions for each of the above criteria based on the CERCLA FS guidance (EPA 1988) are provided below.

Overall Protection of Human Health and the Environment - Each alternative is assessed to determine whether it can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by contaminants present at the site. Each alternative is evaluated on how site risks associated with each exposure pathway are eliminated, reduced, or controlled through treatment, engineering or institutional controls. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Compliance with ARARs - Each alternative is assessed to determine whether it would attain ARARs under federal and state environmental or facility siting laws, and non-promulgated advisories and guidance, or whether it would provide grounds for invoking one of the waivers.

Long-Term Effectiveness and Permanence - Each alternative is assessed for the long-term effectiveness and permanence it presents, along with the degree of certainty that the alternative would prove successful. Factors considered as appropriate include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their T/M/V and propensity to bioaccumulate.

- Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste. This factor addresses the uncertainties associated with land disposal for providing long-term protection from residuals, the assessment of the potential need to replace technical components of the alternative, and the potential exposure pathways and risks posed should the remedial action need replacement.

Reduction of T/M/V Through Treatment - The degree to which each alternative employs treatment that reduces T/M/V is assessed, including how treatment is used to address the principal threats posed by the site. The following factors were considered appropriate:

- The treatment processes employed and the materials they would treat
- The amount of hazardous substances, pollutants, or contaminants that would be destroyed, treated, or recycled
- The degree of expected reduction of T/M/V of the waste due to treatment - and the specification of which reduction(s) are occurring
- The degree to which the treatment is irreversible
- The type and quantity of residuals that would remain following treatment considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents

- The degree to which treatment reduces the inherent hazards posed by principal threats at the site

Short-Term Effectiveness - The short-term effectiveness of each alternative is assessed considering the following:

- Short-term risks and impacts that might be posed to the community during implementation of an alternative
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation
- Time until protection is achieved

Implementability - The ease or difficulty of implementing each alternative is assessed by considering the following types of factors as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies.

- Availability of services and materials, necessary equipment and specialists, and provisions to ensure any necessary additional resources and availability of prospective technologies.

Cost - The types of costs that are assessed include the following:

- Capital costs, including both direct and indirect costs
- Annual O&M, also including long-term monitoring cost and periodic review cost
- Net present worth of capital and O&M costs

The cost estimates are developed based on EPA's guidance: *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 2000). The present worth of each alternative provides the basis for the cost comparison.

The present worth cost with a discount rate represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life. Because inflation and depreciation were not considered in preparing the present worth costs with a discount rate, and all estimated annual and periodic costs are based on present conditions instead of future situations, the present worth cost is underestimated.

The present worth analysis was performed on each remedial alternative with a 7% discount rate over the life-cycle of the alternative. The present value analysis is performed assuming the inflation rate and interest rate are the same on each remedial alternative over the same life-cycle of the alternative. Pursuant to the EPA RI/FS guidance document (EPA 1988), the costs are expected to be within -30 to +50 percent accuracy. Appendix B contains spreadsheets showing each component of the present worth costs.

Supporting Agency (state) Acceptance - Assessment of State concerns would not be completed until comments on the FS report are received but may be discussed, to the extent possible, in the Proposed Plan issued for public comment. State Acceptance is formally documented as part of the Record of Decision. The State concerns that shall be assessed include the following:

- The State's position and key concerns related to the preferred alternative and other alternatives
- State comments on ARARs or the proposed use of waivers

Community Acceptance - This assessment includes determining which components of the alternatives interested persons in the community support, feel uncertain about, or categorically reject. The preferred remedy would be presented to the public in the Proposed Plan. Community input would be solicited during the public comment period. A responsiveness summary would be prepared to address comments received during the public comment period. A summary of the public comments and responses would be included in the ROD. As a result, no assessment of community acceptance is made in this FS Report.

5.2 Detailed Analysis of Remedial Action Alternatives

5.2.1 Alternative 1 - No Action

This alternative is described in Section 4.1.

Overall Protection of Human Health and the Environment

The No Action alternative would not involve any action to protect human health and the environment. This alternative would not eliminate any exposure pathways or reduce the level of risk of the existing groundwater contamination through any means. It also would not provide protection to the environment. This alternative would not meet the RAOs.

Compliance with ARARs

This alternative would not achieve chemical-specific ARARs established for groundwater since no action would be taken. In addition, there is no indication that intrinsic biodegradation is occurring at an effective level, and dispersion and dilution would not effectively reduce the contaminant concentrations to MCLs in a reasonable timeframe. Location- and action-specific ARARs do not apply to this alternative as no remedial action would be conducted.

Long-Term Effectiveness and Permanence
This alternative would not be considered a permanent remedy. It would not have long-term effectiveness. The potential of exposure of contaminated groundwater to site receptors would not be eliminated under this alternative.

Reduction of T/M/V Through Treatment
No reductions of contaminant T/M/V through treatment would be achieved under this alternative. The effective toxicity reduction pathway, biodegradation of chlorinated contaminants, would not be prevalent because of the aerobic nature of the groundwater. The mobility and volume would not change because no treatment would be applied to the groundwater contamination.

Short-Term Effectiveness
Since no remedial action would be implemented at the site, this alternative would not pose short-term risks to onsite workers or the community. It would not have adverse environmental impacts to habitats or vegetation at the site.

Implementability
This alternative could be implemented immediately since no services or permit equivalency would be required.

Cost
There are no capital or O&M costs associated with this alternative.

5.2.2 Alternative 2 - Monitoring

This alternative is described in Section 4.2.

Overall Protection of Human Health and the Environment
The Monitoring alternative would not protect human health or the environment since only monitoring of the groundwater and vapor sampling would be conducted. The institutional controls would restrict the property usage to commercial or light industrial uses and prohibit the installation of groundwater wells, thereby reducing potential human exposure to contaminated groundwater and limited protection of human health. This alternative would not meet the RAOs.

Compliance with ARARs
This alternative would eventually reduce the contaminant concentrations to the MCLs, but not within an acceptable time frame to comply with chemical-specific ARARs. This alternative would meet the action-specific ARARs such as health and safety requirements.

Long-Term Effectiveness and Permanence
This alternative would not provide long-term effectiveness and permanence since it includes only monitoring of the groundwater and no active treatment. The contaminant plume would eventually shrink in size and contaminant concentrations would decrease gradually over time and eventually meet the MCLs.

Reduction of T/M/V Through Treatment

This alternative would not reduce the mobility and volume of contaminants through treatment. The toxicity may be reduced in the long-term through dilution and dispersion. As predicted in the preliminary groundwater model, this alternative would reduce the contamination levels to below the MCLs over time (in 46 years), although no treatment would be applied.

Short-Term Effectiveness

This alternative would include annual groundwater sampling and one round of vapor sampling, which would have a minimal short-term impact to the community and workers. Use of personal protective equipment (PPE) by workers during groundwater sampling would minimize any exposure to contaminants. There would be no adverse environmental impacts to habitats.

Implementability

This alternative would be easy to implement. Groundwater sampling procedures are well developed and approved by EPA during the RI. Standard vapor intrusion sampling procedures would be used. Monitoring equipment is readily available. Monitoring wells are easy to access. Institutional controls would be easy to implement.

Cost

For this alternative, the estimated capital costs include the development of the work plan, SMP, quality assurance project plan, and health and safety plan for the long-term monitoring program.

Although the preliminary groundwater model indicated that it would take 46 years to restore the Magothy aquifer to the MCLs, it also indicated that after 25 years, the size of the PCE and TCE plumes would be significantly reduced (Appendix A, Figure 9a and 10a). Accordingly, the scale of the long-term monitoring program would be reduced. For cost estimating purposes, under this alternative, the long-term monitoring program between years 25 and 46 would only include two multiport wells and the supply wells GWP-10 and GWP-11.

For this alternative, the total present worth with discounting is $2.29 million. Capital cost is $0.30 million and annual long-term groundwater monitoring is $0.15 million for the first 25 years and $0.11 million starting at year 25. Detailed cost estimates are presented in Appendix B.

5.2.3 Alternative 3 - Groundwater Extraction and Ex-Situ Treatment (Pump and Treat)

Alternative 3 is described in Section 4.3.

Overall Protection of Human Health and the Environment

The Groundwater extraction and ex-situ treatment alternative would provide overall protection of human health and the environment. Human exposure to contaminated groundwater would be prevented through treatment of contaminated groundwater with air strippers, and institutional controls, such as well drilling restrictions. This alternative also provides protection to the environment, as contaminated groundwater is extracted and treated at SVP-4E. The contaminant levels in the plume are predicted to be reduced to the MCLs in 35 years by the preliminary groundwater model. This alternative would meet the RAOs.

<u>Compliance with ARARs</u>
This alternative would achieve MCLs, thereby meeting the chemical-specific ARARs through active treatment of the groundwater contamination. This alternative would also meet the action-specific ARARs, such as health and safety, off-gas and water discharge requirements, and the location-specif ARARs, if the treatment facility has the potential to disturb historic landmarks.

<u>Long-Term Effectiveness and Permanence</u>
This alternative would provide long-term effectiveness and permanence. The operation of an extraction well near SVP-4 would expedite the clean up of the contaminant plume and reduce the contaminant concentrations reaching the two supply wells. The overall contaminant plume would shrink in size and decrease in concentrations. The aquifer would be restored to MCLs more rapidly with the active groundwater extraction and treatment.

<u>Reduction of T/M/V Through Treatment</u>
This alternative would reduce the volume and mobility of the contaminant plume through groundwater extraction and would remove the toxicity of extracted groundwater through air stripping. The extraction well upgradient of supply wells GWP-10 and GWP-11 would capture and treat the contaminant plume with relatively high concentrations and prevent the contaminants from migrating to the two supply wells. Under the current pumping rate assumptions, this alternative would also prevent the contaminant plume identified during the RI from migrating downgradient. As predicted in the preliminary groundwater model, this alternative would reduce the contamination levels to below the MCLs in 35 years.

<u>Short-Term Effectiveness</u>
This alternative would include construction of extraction well(s), installation of a treatment facility, and its associated extraction and discharge piping. These activities would temporarily impact the normal use of the parking lot in the office buildings on the west side of the mall. The contractor would coordinate with the land owner and local police for access, traffic control, and an agreeable working schedule to minimize the inconvenience. This alternative would also include groundwater sampling, which would have a minimal short-term impact to the community and workers. Use of PPE by workers during site activities, groundwater sampling, and construction would minimize the exposure to workers. There would be no adverse environmental impacts to habitats.

Implementability
This alternative would be easy to implement. Installation of a groundwater extraction well(s) and construction of a treatment system are proven technologies. Experienced vendors can be procured for the services. Installation of multiport monitoring wells was achieved at this site during the RI. The same groundwater sampling procedures approved by EPA during the RI would be followed. The equipment for construction and sampling are readily available. Institutional controls would be easy to implement.

Cost
For this alternative, the capital costs include the evaluation and replacement of the two air strippers at supply wells GWP-10 and GWP-11, the pre-design investigation, one round of vapor sampling at six commercial buildings during the winter heating season, groundwater modeling, design of a pump-and-treat system, development of a long-term monitoring program, and development of the SMP. The O&M of the new groundwater treatment system would last for 10 years. The long-term monitoring would be for 35 years. However, after 25 years, the size of the contaminant plume would be significantly reduced as predicted in the preliminary groundwater model. For cost estimating purposes, the scale of the long-term monitoring program would be reduced to include two multiport wells and supply wells GWP-10 and GWP-11 from year 26 to year 35. It was also assumed that one extraction well would be required. The final number of extraction wells would be determined after the completion of the pre-design investigation.

The total present worth cost with discounting for this alternative is approximately $13.16 million. Capital cost associated with this alternative is $6.24 million; the annual O&M cost, including O&M for the pump and treat system and annual monitoring sampling, is $0.85 million for the first 25 years and $0.79 million beginning in year 25. Detailed cost estimates are presented in Appendix B.

5.3 Comparison of Detailed Analysis of Remedial Action Alternatives

Table 5-1 summarizes the comparison of the three groundwater alternatives against the seven criteria. Table 5-2 summarizes the duration of each alternative.

Overall Protection of Human Health and the Environment
Alternative 1 - No Action would not include any monitoring or remedial measures, and as such, would not be protective of human health and the environment. Alternatives 2 would also not be protective of human health and the environment since it only includes monitoring of the groundwater plume and vapor sampling. Alternative 2 provides institutional controls which would result in minimal protection of human health and the environment. Alternative 3 would provide overall protection of human health and the environment through implementation of a remedial pump and treat system to extract and treat the groundwater contamination and vapor intrusion mitigation, if deemed necessary.

Compliance with ARARs
Alternatives 1 and 2 would not comply with chemical-specific ARARs because no groundwater treatment would be undertaken. Alternative 2 would comply with action-specific ARARs such as health and safety requirements. Alternative 3 would comply with chemical-specific ARARs through active removal and treatment of groundwater contamination. Alternative 3 would also comply with location- and action-specific ARARs.

Long-Term Effectiveness and Permanence
Alternative 1 would not provide long-term effectiveness and permanence since no action is taken to remove contamination from the groundwater. Alternative 2 would provide a small degree of long-term effectiveness and permanence through institutional controls. Alternative 3 would provide long-term effectiveness and permanence by extracting contaminated groundwater from the aquifer and treating it to remove the contaminants. Alternative 3 also would include vapor intrusion sampling in six commercial buildings.

Reduction of T/M/V Through Treatment
Alternatives 1 and 2 would not reduce T/M/V through treatment since no treatment would be implemented. Alternative 3 would reduce the mobility and volume of the contaminant plume through groundwater extraction and reduce the toxicity of water through ex-situ treatment using air strippers. Alternative 3 would prevent the contaminant plume with concentrations above the MCLs from migrating downgradient. Alternative 3 would also would include vapor intrusion sampling in six commercial buildings. Vapor mitigation would be implemented, if the need is indicated by sample results.

Short-Term Effectiveness
Alternative 1 would not have any short-term impact. Alternative 2 would have minimal short-term impact to the community and the environment during annual sampling. Alternative 3 would have some impact to the community, but the duration would be short and the disturbance would be minimal.

Implementability
All three alternatives are implementable. Alternative 1 would be the easiest to implement, since it involves no action. Alternative 2 would be the next easiest to implement, since it only involves annual sampling of monitoring wells and would not have any ground intrusion activities. Alternative 3 would also be easy to implement. Access for installation of extraction well(s) and construction of a treatment facility would be required and various contractors would need to be procured. Construction activities could be conducted using standard equipment and procedures.

Cost
Alternative 1 would not involve any costs. Alternative 2 would have the lowest costs since it only includes annual sampling of monitoring wells and one round of vapor intrusion sampling of the commercial buildings. Alternative 3 would have medium

capital and O&M costs. The costs associated with Alternative 3 primarily reflect the installation and operation of a groundwater extraction and treatment system and vapor intrusion sampling in the commercial buildings. Table 5-3 summarizes the costs for each alternative.

Section Six

Section 6
References

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Tables

Table 1-1
Historical Groundwater Results
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Well ID	Aquifer	Screened Interval (feet bgs)	Diameter	Status	Date Sampled	1,2-DCE	TCE	PCE	Total VOCs
FORMER COOLING WATER WELL									
N-8050 (100 Ring Road)	Magothy	300-328	8 inches	Inactive	06/23/81	975	3,700	61	4,800
					05/18/82	1,500	2,400	54	4,100
					08/04/83	720	2,100	34	2,900
					08/04/83	1,400	13,000	36	14,000
					05/02/84	2,800	38,000	87	41,000
					05/02/84	2,500	23,000	77	26,000
					08/07/84	1,100	13,000	47	14,000
					11/15/93	110	230	2	342
					05/25/95	10	14	<2	26
					06/24/03	48	55	1	105
SUPPLY WELLS									
GWP-10	Magothy	377-417	18 inches	Active with air stripper; 1,400 gpm capacity	09/20/77		7		7
					10/17/78	<1	11	1	12
					10/02/79		10	1	11
					10/06/80	<30	11	4	20
					10/13/81	<1	8	2	14
					03/16/82		6	2	14
					08/24/83	<4	9	1	13
					07/13/84		18	3	21
					07/09/85		33	6	39
					05/27/86		38		49
					05/05/87		53		74
					07/02/88		95		95
					11/09/89	<0.5	120	33	181
					10/15/90		230	100	377
					09/20/91	<0.5	420	300	720
					07/13/92	43	480	340	865
					12/06/93	37	630	720	1,390
					06/15/94	100	720	680	1,512
					03/13/95	38	630	640	1,308
					04/11/96	95	1,400	750	2,260
					10/08/98	14	170	1,100	1,417
					09/17/99	37	400	480	1,024
					03/20/00	24	290	480	905
					02/21/01	36	330	340	729
					01/07/02	38	370	270	700
					09/02/03	26	270	200	518
					01/06/04	26	260	210	514
GWP-11	Magothy	370-410	18 inches	Active with air stripper; 1,400 gpm capacity	09/20/77		9	<2	9
					11/08/78	1	13	1	15
					09/11/79		12	1	27
					10/06/80	<30	14	5	24
					09/15/81		14	5	24
					09/14/82	1	13		14
					08/24/83	<4	15	2	24
					04/11/84	<4	18	3	27
					05/07/85		33	5	45
					07/17/86		18		18
					05/07/87		23		44
					09/26/88		48	4	152
					05/30/89		62	2	64
					12/17/90		94	7	169
					07/19/91	16	240	26	317
					12/14/92		330	11	347
					11/22/93	53	630	180	875
					06/15/94	99	760	240	1,147
					01/16/95	46	700	130	890
					04/11/96	80	910	30	1,086
					07/18/97	64	750	250	1,083
					01/05/98	58	710	240	1,021
					01/19/99	47	500	210	765
					01/04/00	43	410	110	575
					01/15/01	41	350	38	459
					08/19/02	21	240	24	303
					12/03/03	13	140	16	186
					10/25/2004	20	200	66	305

Notes:
All results are in micrograms per liter (μg/L)
Blank = Not Analyzed
bgs = below ground surface
gpm = gallons per minute
1,2-DCE = 1,2-dichloroethene
TCE = trichloroethene
PCE = tetrachloroethylene
VOC = volatile organic compound

Table 1-2
Summary of RI Field Activities
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Field Activity	Dates
Hydrogeological Investigation	
Surface Geophysical Survey	6/20/05
Drilling and Groundwater Screening; Downhole Gamma Logging	7/10/05-12/2/05
Outer Screen and Casing Installation and Development; Multi-port Monitoring Well Installation	8/26/05-3/17/06
Existing Well Assessment and Redevelopment	2/1/06-2/4/06
Groundwater Sampling and Water Levels (Multi-port Wells, Existing Monitoring Wells, Supply Wells)	3/25/06-7/20/06
Well Location Survey	4/6/06
Source Area Soil Gas Investigation	
Surface Geophysical Survey	12/8/05-12/13/05
Soil Gas Screening	12/12/05-1/4/06
Soil Gas Outdoor Building Boring TO-15 Sampling	1/5/06-1/6/06
Ecological Investigation	9/7/06
Cultural Resources Survey	5/05

Table 1-3
Groundwater VOC Screening Results
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

	SVP-1 Screening Results									
Sample ID	**TCE**	**PCE**	**1,1,1-TCA**	**1,1-DCA**	**1,1-DCE**	**Freon 113**	**Acetone**	**Toluene**	**TCFM**	**MTBE**
SVPGW01-50	ND	ND	ND	ND	ND	ND	12	7.1	12	7.6
SVPGW01-70	ND	ND	ND	ND	ND	ND	12	6.2	12	8.3
SVPGW01-90	ND	ND	ND	ND	ND	ND	8.3	2.4	24	8.5
SVPGW01-110	ND	ND	ND	1.2	ND	2.2	9.7	4.4	33	13
SVPGW01-130	ND	ND	ND	1	ND	ND	11	15	15	9.7
SVPGW01-150	ND	ND	ND	1.2	ND	1.9	11	11	34	15
SVPGW01-170	ND	ND	ND	1.2	ND	1.8	ND	8.4	42	18
SVPGW01-190	ND	ND	ND	1.4	ND	ND	ND	11	37	15
SVPGW01-210	ND	ND	ND	ND	ND	ND	ND	8	38	16
SVPGW01-230	ND	ND	ND	2.6	ND	4.8	ND	4.3	100	27
SVPGW01-250	ND	ND	ND	1.6	ND	3	ND	6.6	61	19
SVPGW01-270	ND	ND	ND	1.4	ND	1.9	ND	7.7	42	16
SVPGW01-290	ND	ND	ND	ND	ND	4	ND	4.1	87	20
SVPGW01-310	ND	ND	ND	ND	ND	3.2	ND	4	70	20
SVPGW01-330	ND	ND	ND	ND	ND	3	ND	4.5	72	19
SVPGW01-350	ND	ND	ND	2.4	ND	3.1	ND	4.8	79	19
SVPGW01-370	1.2	ND	1.3	3.4	1.7	2.3	7	2.8	70	14
SVPGW01-390	ND	1	ND	2.4	ND	2.9	14	5.7	75	19
SVPGW01-410	ND	ND	ND	1.8	ND	2	9.1	6.2	59	17
SVPGW01-430	ND	ND	ND	1.3	ND	2.9	6.5	8.1	59	16
SVPGW01-450	ND	ND	ND	1.6	ND	2.1	16	5.1	54	17

Abbreviations:

DCA - Dichloroethane
DCE - Dichloroethene
MTBE - Methyl tert-butyl ether
PCE - Tetrachloroethene
ND - not detected
SVPGW - vertical profile groundwater screening
TCA - Trichloroethane
TCE - Trichloroethene
TCFM - Trichlorofluoromethane
VOC - Volatile Organic Compound

All results in micrograms per liter (µg/L)

Table 1-3
Groundwater VOC Screening Results
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Sample ID	SVP-2 Screening Results						
	TCE	TCFM	Dichlorofluoromethane	Cis-1,2-DCE	1,1,2-Trichloro 1,2,2-Trifluoroethane	Acetone	Toluene
SVPGW02-50	6	ND	ND	ND	ND	ND	ND
SVPGW02-70	18	ND	ND	ND	ND	ND	ND
SVPGW02-90	21	ND	7	ND	ND	ND	ND
SVPGW02-110	16	ND	6	ND	ND	6	7
SVPGW02-130	20	ND	ND	ND	ND	ND	ND
SVPGW02-150	28	ND	6	ND	ND	ND	ND
SVPGW02-170	18	10	7	ND	ND	ND	ND
SVPGW02-170 D	18	11	6	ND	ND	ND	ND
SVPGW02-190	24	17	8	6	ND	6	7
SVPGW02-210	20	16	ND	6	ND	ND	ND
SVPGW02-230	24	37	8	6	ND	ND	ND
SVPGW02-250	37	35	ND	16	ND	ND	ND
SVPGW02-270	23	39	10	6	ND	ND	ND
SVPGW02-290	26	46	11	9	ND	ND	ND
SVPGW02-310	19	96	ND	8	ND	ND	ND
SVPGW02-330	15	100	ND	ND	ND	ND	ND
SVPGW02-350	15	120	ND	ND	ND	ND	ND
SVPGW02-350 D	15	120	ND	ND	ND	ND	ND
SVPGW02-370	13	140	ND	ND	ND	6	ND
SVPGW02-390	10	190	ND	ND	ND	7	ND
SVPGW02-410	12	270	ND	ND	8	10	7
SVPGW02-430	16	690	ND	ND	19	6	ND
SVPGW02-450	27	1900	ND	ND	51	ND	ND

Abbreviations:
DCE - Dichloroethene
SVPGW - vertical profile groundwater screening
TCE - Trichloroethene
TCFM - Trichlorofluoromethane
VOC - Volatile Organic Compound
ND - not detected

All results in micrograms per liter (µg/L)

Table 1-3
Groundwater VOC Screening Results
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Sample ID	SVP-3 Screening Results						
	TCE	Acetone	Dichlorodifluoromethane	TCFM	1,1-DCA	1,1-DCE	Toluene
SVPGW03-50	ND	13	ND	ND	ND	ND	13
SVPGW03-70	ND	8	ND	ND	ND	ND	9
SVPGW03-90	ND	ND	ND	ND	ND	ND	ND
SVPGW03-110	ND	ND	ND	ND	ND	ND	ND
SVPGW03-130	ND	ND	8	ND	ND	ND	ND
SVPGW03-130D	ND	ND	7	ND	ND	ND	ND
SVPGW03-150	ND	ND	9	ND	ND	ND	ND
SVPGW03-170	ND	ND	12	ND	ND	ND	ND
SVPGW03-190	ND	ND	12	ND	ND	ND	ND
SVPGW03-210	ND	ND	9	ND	ND	ND	ND
SVPGW03-230	ND	6	7	ND	ND	ND	ND
SVPGW03-250	ND	9	6	ND	ND	ND	ND
SVPGW03-270	ND	10	5	ND	ND	ND	ND
SVPGW03-290	ND	ND	10	ND	ND	ND	ND
SVPGW03-310	ND	6	6	ND	ND	ND	ND
SVPGW03-330	ND	6	8	ND	ND	ND	ND
SVPGW03-350	ND	ND	ND	ND	ND	ND	ND
SVPGW03-370	8	ND	ND	8	ND	ND	ND
SVPGW03-390	3.2 J	ND	5.2 J	15	3.4 J	1.4 J	ND
SVPGW03-390D	3.2 J	ND	5.7 J	14	3.4 J	1.4 J	ND
SVPGW03-410	ND	ND	4.7 J	5 J	1.8 J	ND	ND
SVPGW03-430	ND	ND	5.7 J	5.9 J	2 J	ND	1.3 J
SVPGW03-450	1.5 J	ND	4.2 J	16	1.5 J	ND	2.1 J

Abbreviations:

DCA - Dichloroethane
DCE - Dichloroethene
SVPGW - vertical profile groundwater screening
ND - not detected
TCE - Trichloroethene
TCFM - Trichlorofluoromethane
VOC - Volatile Organic Compound
J - estimated value

All results in micrograms per liter (μg/L)

Table 1-3
Groundwater VOC Screening Results
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Sample ID	SVP-4 Screening Results				
	PCE	TCE	cis-1,2-DCE	TCFM	Acetone
SVPGW-04-49	14	ND	ND	ND	23
SVPGW-04-69	21	ND	ND	ND	17
SVPGW-04-89	25	ND	ND	ND	10
SVPGW-04-109	23	ND	ND	ND	7
SVPGW-04-129	8	ND	ND	ND	15
SVPGW-04-149	58	110	ND	ND	13
SVPGW-04-169	78	130	ND	ND	11
SVPGW-04-189	110	140	ND	ND	10
SVPGW-04-209	61	80	ND	ND	17
SVPGW-04-229	50	68	ND	ND	15
SVPGW-04-249	78	100	ND	ND	11
SVPGW-04-269	64	110	6	ND	15
SVPGW-04-289	31	110	7	ND	12
SVPGW-04-309	16	88	6	ND	11
SVPGW-04-329	10	65	6	8	7
SVPGW-04-349	6	63	7	9	8
SVPGW-04-369	ND	54	7	10	6
SVPGW-04-389	ND	53	6	10	8
SVPGW-04-409	ND	56	7	14	ND
SVPGW-04-423	ND	ND	ND	23	8
SVPGW-04-449	NA	NA	NA	NA	NA

Sample ID	SVP-5 Screening Results		
	TCE	Acetone	Dichlorodifluoromethane
SVPGW-05-50	ND	8	ND
SVPGW-05-70	ND	6	ND
SVPGW-05-90	ND	8	ND
SVPGW-05-110	6	6	ND
SVPGW-05-130	7	10	ND
SVPGW-05-150	11	12	ND
SVPGW-05-170	ND	19	ND
SVPGW-05-190	ND	17	ND
SVPGW-05-210	ND	16	ND
SVPGW-05-230	11	ND	6
SVPGW-05-250	19	12	ND
SVPGW-05-270	11	17	7
SVPGW-05-290	11	17	ND
SVPGW-05-310	8	20	8
SVPGW-05-330	6	12	ND
SVPGW-05-350	12	10	10
SVPGW-05-370	10	10	12
SVPGW-05-390	8	12	6
SVPGW-05-410	9	13	ND
SVPGW-05-430	7	16	ND
SVPGW-05-450	ND	23	ND

Abbreviations:
DCE - Dichloroethene
PCE - Tetrachloroethene
SVPGW - vertical profile groundwater screening
ND - not detected
TCE - Trichloroethene
TCFM - Trichlorofluoromethane
VOC - Volatile Organic Compound

All results in micrograms per liter (μg/L)

Table 1-3
Groundwater VOC Screening Results
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Sample ID	SVP-6 Screening Results					
	1,1-DCE	cis-1,2-DCE	1,1,1-TCA	1,1-DCA	Acetone	Toluene
SVPGW06-50	9	6	10	ND	ND	10
SVPGW06-70	9	6	10	ND	ND	10
SVPGW06-90	16	10	16	7	7	30
SVPGW06-110	6	ND	6	ND	ND	10
SVPGW06-130	7	ND	6	ND	ND	9
SVPGW06-130D	8	ND	ND	ND	ND	8
SVPGW06-150	10	8	12	ND	ND	9
SVPGW06-170	11	8	13	ND	ND	6
SVPGW06-190	8	6	10	ND	ND	16
SVPGW06-210	ND	ND	ND	ND	ND	6
SVPGW06-230	ND	ND	ND	ND	ND	ND
SVPGW06-250	ND	ND	ND	ND	ND	ND
SVPGW06-270	ND	ND	ND	ND	ND	ND
SVPGW06-290	ND	ND	ND	ND	ND	ND
SVPGW06-310	ND	ND	ND	ND	ND	ND
SVPGW06-330	ND	ND	ND	ND	ND	ND
SVPGW06-350	ND	ND	ND	ND	ND	ND
SVPGW06-370	ND	ND	ND	ND	ND	ND
SVPGW06-390	ND	ND	ND	ND	7	ND
SVPGW06-410	ND	ND	ND	ND	ND	7
SVPGW06-430	ND	ND	ND	ND	8	7
SVPGW06-450	ND	ND	ND	ND	7	25

Abbreviations:

DCA - Dichloroethane
DCE - Dichloroethene
SVPGW - vertical profile groundwater screening
ND - not detected
TCA - Trichloroethane
TCE - Trichloroethene
VOC - Volatile Organic Compound

All results in micrograms per liter (µg/L)

Table 1-3
Groundwater VOC Screening Results
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Sample ID	SVP-7 Screening Results			
	TCE	cis-1,2-DCE	Acetone	Toluene
SVPGW07-50	3.2	ND	5.5	28.0
SVPGW07-70	2.5	ND	ND	6.6
SVPGW07-90	4.4	ND	ND	7.2
SVPGW07-110	3.9	ND	ND	13.0
SVPGW07-130	4.1	ND	ND	8.9
SVPGW07-150	4.8	ND	ND	9.9
SVPGW07-170	4.7	ND	ND	7.8
SVPGW07-190	5.0	ND	ND	4.1
SVPGW07-210	5.2	ND	ND	3.2
SVPGW07-230	4.4	ND	ND	1.3
SVPGW07-250	5.4	ND	ND	1.3
SVPGW07-270	5.1	ND	ND	1.3
SVPGW07-290	5.4	ND	ND	1.2
SVPGW07-310	4.3	ND	ND	1.2
SVPGW07-330	4.3	ND	ND	2.4
SVPGW07-350	4.0	ND	ND	2.5
SVPGW07-370	4.8	ND	ND	ND
SVPGW07-390	7.7	1.1	ND	ND
SVPGW07-410	5.9	ND	ND	ND
SVPGW07-430	10.0	1.8	ND	ND
SVPGW07-450	4.4	ND	ND	ND

Sample ID	SVP-8 Screening Results	
	Acetone	Toluene
SVPGW08-50	7	35
SVPGW08-70	9	130
SVPGW08-90	6	33
SVPGW08-110	8	71
SVPGW08-130	8	63
SVPGW08-150	6	16
SVPGW08-170	6	35
SVPGW08-190	ND	17
SVPGW08-210	6	13
SVPGW08-210D	6	14
SVPGW08-230	8	11
SVPGW08-250	8	11
SVPGW08-270	8	ND
SVPGW08-290	12	ND
SVPGW08-310	9	ND
SVPGW08-330	8	ND
SVPGW08-350	8	ND
SVPGW08-370	7	ND
SVPGW08-370D	ND	ND
SVPGW08-390	ND	ND
SVPGW08-410	ND	ND
SVPGW08-430	ND	ND
SVPGW08-450	ND	ND

Abbreviations:
DCE - Dichloroethene
SVPGW - vertical profile groundwater screening
TCE - Trichloroethene
VOC - Volatile Organic Compound
ND - not detected

All results in micrograms per liter (μg/L)

Table 1-4
Multi-Port Well VOC Results - Round 1
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name		GWM-1 (background)								
		Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10
		400 to 405 ft	370 to 375 ft	315 to 320 ft	290 to 295 ft	250 to 255 ft	200 to 205 ft	150 to 155 ft	100 to 105 ft	50 to 55 ft
LDL VOCs	SSGWSC	GWM-01-2	GWM-01-3	GWM-01-4	GWM-01-5	GWM-01-6	GWM-01-7	GWM-01-8	GWM-01-9	GWM-01-10
Tetrachloroethene	**5**	**0.21 J**	**0.24 J**	**0.38 J**	**0.28 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Trichloroethene	**5**	**0.3 J**	**0.77**	**0.5**	**0.32 J**	**0.49 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
1,1-Dichloroethene	**5**	**0.32 J**	**0.32 J**	**0.64**	**0.55 J**	**0.61**	**0.12 J**	**0.5 U**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**0.5 U**	**0.5 U**	**0.5 U**	**1.3 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Carbon Tetrachloride	**5**	**0.5 U**	**0.5 U**	**0.5 U**	**1.3 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	0.5 UJ	0.5 U	0.5 UJ	1.3 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ
Chloromethane	5	0.5 U	0.5 U	0.5 U	1.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	5	0.5 U	0.5 U	0.5 U	1.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	6.5	0.37 J	6.8	24	140	1.8	0.32 J	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.19 J	0.5 U	0.13 J	0.77 J	3.6	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 R	13 U	5 U	5 U	5 U	5 U	5 U
Carbon Disulfide	50	0.5 U	0.5 U	0.5 U	1.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	1	0.5 U	0.5 U	1.3 U	0.5 UJ	0.5 UJ	0.92 UJ	0.5 UJ	0.5 UJ
trans-1,2-Dichloroethene	5	0.5 U	0.5 U	0.5 U	1.3 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ
Methyl tert-Butyl Ether	10	1	0.5 U	1.5	8.2	30	0.84	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	5	1.1	2.7	1.8	0.98 J	1.7	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	50	5 U	5 U	5 R	13 U	5 U	5 U	5 U	5 U	5 U
Chloroform	7	0.12 J	0.5 U	0.2 J	1.3 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ
1,1,1-Trichloroethane	5	0.38 J	0.93	0.51	0.26 J	0.38 J	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	1	0.5 U	0.5 U	0.5 U	1.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	1.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.5 U	0.5 U	1.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	1.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylenes (total)	5	0.5 U	0.5 U	0.5 U	1.3 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	1.3 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (μg/L)
Site-related VOCs are bolded
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-4
Multi-Port Well VOC Results - Round 1
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-2 Port 1 450 to 455 ft GWM-02-1	Port 2 410 to 415 ft GWM-02-2	Port 3 370 to 375 ft GWM-02-3	Port 4 330 to 335 ft GWM-02-4	Port 5 290 to 295 ft GWM-02-5	Port 6 250 to 255 ft GWM-02-6	Port 7 190 to 195 ft GWM-02-7	Port 8 150 to 155 ft GWM-02-8	Port 9 100 to 105 ft GWM-02-9	Port 10 50 to 55 ft GWM-02-10
Tetrachloroethene	**5**	**2.4**	**1.4**	**1.6**	**2.8**	**5.8**	**1.8**	**3.2**	**2.8**	**0.86**	**0.68**
Trichloroethene	**5**	**22**	**13**	**16**	**23**	**24**	**25**	**18**	**25**	**20**	**4.9**
1,1-Dichloroethene	**5**	**0.5 U**	**0.46 J**	**0.41 J**	**0.5 U**	**0.5 U**	**1 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**0.97**	**0.86**	**2.7**	**5.2**	**4.9**	**8.4**	**0.29 J**	**0.36 J**	**0.8**	**0.69**
Carbon Tetrachloride	**5**	**0.14 J**	**0.13 J**	**0.5 U**	**0.5 U**	**0.1 J**	**1 U**	**0.16 J**	**0.5 U**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	6.6	4.7	3.5	3.9	10	2.9 J	7.5	6.9	3.2	2.2
Chloromethane	5	0.31 J	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.19 J
Chloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	1.2	58	0.95	0.96	3.1	0.36 J	0.55	0.33 J	0.43 J	0.39 J
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5 U	1.2 J	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 U	5 U	5 U	10 U	5 U	5 U	5 U	5 U
Carbon Disulfide	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	0.14 J	0.5 U	0.5 U	0.15 J	0.5 U	1 U	0.5 U	0.5 U	0.38 J	0.7
trans-1,2-Dichloroethene	5	0.5 U	0.5 U	0.19 J	0.26 J	0.24 J	0.81 J	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.96	0.34 J	0.37 J	0.6	0.43 J	0.82 J	0.44 J	1.4	3	0.24 J
1,1-Dichloroethane	5	0.12 J	1.2	1.1	0.26 J	0.17 J	0.24 J	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	10 U	5 U	5 U	5 U	5 U
Chloroform	7	0.45 J	0.62	0.31 J	0.34 J	0.24 J	1 U	0.34 J	0.22 J	0.5 U	0.5 U
1,1,1-Trichloroethane	5	0.5 U	0.24 J	0.31 J	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylenes (total)	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (µg/L)
Site-related VOCs are bolded
U = undetected
J = Result is estimated due to exceeded quality control criteria
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ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-4
Multi-Port Well VOC Results - Round 1
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

		GWM-3						
Chemical Name LDL VOCs	**SSGWSC**	**Port 1 450 to 455 ft GWM-03-1**	**Port 2 390 to 395 ft GWM-03-2**	**Port 3 370 to 375 ft GWM-03-3**	**Port 4 290 to 295 ft GWM-03-4**	**Port 5 170 to 175 ft GWM-03-5**	**Port 6 100 to 105 ft GWM-03-6**	**Port 7 50 to 55 ft GWM-03-7**
Tetrachloroethene	**5**	**0.2 J**	**0.39 J**	**0.25 J**	**0.54**	**0.39 J**	**0.65**	**0.72**
Trichloroethene	**5**	**1.9**	**3.3**	**8.9**	**0.5 U**	**0.4 J**	**0.5 U**	**0.5 U**
1,1-Dichloroethene	**5**	**0.11 J**	**0.84**	**0.27 J**	**0.12 J**	**0.15 J**	**0.23 J**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**0.5 U**	**0.25 J**	**0.39 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Carbon Tetrachloride	**5**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	0.5 U	0.48 J	0.17 J	0.22 J	1.9	0.5 U	0.5 U
Chloromethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	20	6.8	7.1	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Disulfide	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.5 U	0.5 U	0.5 U	0.5 U	1.6	0.44 J	0.5 U
1,1-Dichloroethane *	5	0.41 J	3.5	2.6	0.25 J	0.74	0.66	0.18 J
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	0.28 J	0.87	0.89	0.62	0.43 J	0.91	0.95
Benzene	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylenes (total)	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (μg/L)
Site-related VOCs are bolded
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-4
Multi-Port Well VOC Results - Round 1
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-4 Port 1 420 to 425 ft GWM-04-1	Port 2 400 to 405 ft GWM-04-2	Port 3 350 to 355 ft GWM-04-3	Port 4 305 to 310 ft GWM-04-4	Port 5 285 to 290 ft GWM-04-5	Port 6 245 to 250 ft GWM-04-6	Port 7 185 to 190 ft GWM-04-7	Port 8 145 to 150 ft GWM-04-8	Port 9 100 to 105 ft GWM-04-9	Port 10 45 to 50 ft GWM-04-10
Tetrachloroethene	**5**	**7.3**	**20**	**21**	**180**	**220**	**350**	**14**	**41**	**15**	**0.37 J**
Trichloroethene	**5**	**30**	**26**	**64**	**280**	**260**	**220**	**260**	**90**	**2.7**	**1.3**
1,1-Dichloroethene	**5**	**1.2**	**1.7**	**1.3 J**	**8.9**	**7.8**	**5.5 J**	**2.2 J**	**0.57**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**0.41 J**	**0.82 J**	**1.4 J**	**3.9 J**	**3.6 J**	**5.3 J**	**2.2 J**	**2.3**	**0.89**	**0.1 J**
Carbon Tetrachloride	**5**	**0.4 J**	**1.3**	**2.5 U**	**8.4 U**	**6.3 U**	**13 U**	**6.3 U**	**0.1 J**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	1 UJ	1 UJ	5.2 J	97 J	64 J	15 J	4.3 J	2.7 J	0.67 J	0.5 UJ
Chloromethane	5	1 U	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
Chloroethane	5	1 U	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	31	16	2.8	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	1 UJ	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
Acetone	50	10 U	11 U	32 U	120 U	83 U	160 U	87 U	5 U	5 U	5 U
Carbon Disulfide	50	1 U	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	1 UJ	1.6 U	2 J	3.8 J	2.3 J	13 UJ	1.8 J	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	5	1 UJ	1 UJ	2.5 UJ	8.4 UJ	6.3 UJ	13 UJ	6.3 UJ	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	3.4	1.7	6.5	10	12	17	45	27	0.32 J	0.5 U
1,1-Dichloroethane	5	2.7	3.3	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
2-Butanone	50	10 U	10 U	25 U	84 U	63 U	130 U	63 U	5 U	5 U	5 U
Chloroform	7	1.7 UJ	2.4 UJ	2.5 UJ	8.4 UJ	6.3 UJ	13 UJ	6.3 UJ	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	0.85 J	1.2	2.5 U	2.4 J	2.3 J	13 U	6.3 U	0.27 J	0.5 U	0.5 U
Benzene	1	1 U	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.22 J	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	1 U	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
Toluene	5	1 U	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	1 U	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
Xylenes (total)	5	1 U	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	1 U	1 U	2.5 U	8.4 U	6.3 U	13 U	6.3 U	0.5 U	0.5 U	0.5 U

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (μg/L)
Site-related VOCs are bolded
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Table 1-4
Multi-Port Well VOC Results - Round 1
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-5 Port 1 430 to 435 ft GWM-05-1	Port 2 405 to 410 ft GWM-05-2	Port 3 355 to 360 ft GWM-05-3	Port 4 310 to 315 ft GWM-05-4	Port 5 290 to 295 ft GWM-05-5	Port 6 250 to 255 ft GWM-05-6	Port 7 190 to 195 ft GWM-05-7	Port 8 150 to 155 ft GWM-05-8	Port 9 95 to 100 ft GWM-05-9	Port 10 45 to 50 ft GWM-05-10
Tetrachloroethene	5	0.5	0.95	0.55	0.72	0.62	0.31 J	0.5	0.33 J	0.81	0.11 J
Trichloroethene	5	6.6	32	12	14	19	5	2.6	0.91	4.4	0.11 J
1,1-Dichloroethene	5	1	1	0.37 J	0.4 J	0.44 J	0.5 U	2.7	2.8	1.2	0.5 U
cis-1,2-Dichloroethene	5	0.56	1.8	0.97	1.1	1.7	0.58	0.23 J	0.12 J	0.34 J	0.5 U
Carbon Tetrachloride	5	0.18 J	0.25 J	0.17 J	0.5 U	0.12 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dichlorodifluoromethane	5	1.8	2	22	17	3.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloromethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.19 J
Chloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	0.5 U	1.2	0.37 J	0.46 J	0.56	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Disulfide	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.5 U	0.5 U	0.8	1.8	1.1	0.7	0.5	0.85	0.85	0.7
1,1-Dichloroethane	5	1.6	1.8	2	3	1.8	0.7	4.4	4.7	3.1	0.5 U
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.27 J	0.24 J	0.5 U
1,1,1-Trichloroethane	5	0.57	0.57	0.15 J	0.18 J	0.26 J	0.2 J	1.6	1.5	0.52	0.5 U
Benzene	1	0.5 U	0.5 U	0.12 J	0.11 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylenes (total)	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:
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Table 1-4
Multi-Port Well VOC Results - Round 1
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-6 Port 1 445 to 450 ft GWM-06-1	Port 2 365 to 370 ft GWM-06-2	Port 3 245 to 250 ft GWM-06-3	Port 4 175 to 180 ft GWM-06-4	Port 5 100 to 105 ft GWM-06-5	Port 6 45 to 50 ft GWM-06-6	Port 6 45 to 50 ft Duplicate
Tetrachloroethene	**5**	**0.23 J**	**0.5 U**	**0.7**	**0.52**	**1.1**	**0.5 U**	**0.11 J**
Trichloroethene	**5**	**1.7**	**0.33 J**	**8.2**	**2.1**	**4.3**	**0.26 J**	**0.29 J**
1,1-Dichloroethene	**5**	**6.6**	**3.7**	**13**	**14**	**22**	**1.5**	**1.2**
cis-1,2-Dichloroethene	**5**	**1.8**	**0.69**	**4.8 J**	**4.1 J**	**22 J**	**0.26 J**	**0.32 J**
Carbon Tetrachloride	**5**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	0.59	0.29 J	0.58	0.36 J	0.75	0.5 U	0.5 U
Chloromethane	5	0.24 J	0.47 J	2.5	0.5 U	0.5 U	0.76 J	0.5 U
Chloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	3.3	0.5 U	0.5 U
Trichlorofluoromethane	5	0.5 U	0.13 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.15 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	12	21	9.8	28	9.6	43	29
Carbon Disulfide	50	1.5	0.6	0.94	0.25 J	0.35 J	0.66 J	0.35 J
Methylene Chloride	5	1.1 U	0.5 U	0.38 J	0.56 J	0.84	0.5 U	0.5 U
trans-1,2-Dichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.5 U	0.5 U	0.17 J	0.2 J	0.34 J	0.15 J	0.5 U
1,1-Dichloroethane	5	2	0.99	3.8	6.5	15	0.25 J	0.31 J
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	5 U	4.3 J
Chloroform	7	0.5	0.11 J	0.55	0.53	2.1	0.5 U	0.5 U
1,1,1-Trichloroethane	5	7.4	3	14	15	21	1.7	2.3
Benzene	1	0.5 U	0.5 U	0.5 U	0.5 U	0.11 J	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	8.5	6.6	110	42	23	790	810
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.47 J	0.59
Xylenes (total)	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.27 J
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 J	0.27 J

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (μg/L)
Site-related VOCs are bolded
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-4
Multi-Port Well VOC Results - Round 1
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-7													
		Port 1 445 to 450 ft		Port 2 425 to 430 ft		Port 3 310 to 315 ft		Port 4 205 to 210 ft		Port 5 100 to 105 ft				Port 6 45 to 50 ft	
		GWM-07-1		GWM-07-2		GWM-07-3		GWM-07-4		GWM-07-5		Duplicate		GWM-07-6	
Tetrachloroethene	**5**	**0.5**	**U**	**0.11**	**J**	**2.2**		**0.21**	**J**	**0.45**	**J**	**0.7**		**0.5**	**U**
Trichloroethene	**5**	**0.18**	**J**	**0.66**		**9.4**		**0.38**	**J**	**1.2**		**1.8**		**0.5**	**U**
1,1-Dichloroethene	**5**	**0.18**	**J**	**1.4**		**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**
cis-1,2-Dichloroethene	**5**	**0.5**	**U**	**0.5**	**U**	**1**		**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**
Carbon Tetrachloride	**5**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**
Dichlorodifluoromethane	5	0.14	J	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Chloromethane	5	0.14	J	0.5	U	0.5	U	0.16	J	0.14	J	0.23	J	0.5	U
Chloroethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Trichlorofluoromethane	5	0.5	U	0.5	U	0.42	J	0.5	U	0.5	U	0.5	U	0.5	U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Acetone	50	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Carbon Disulfide	50	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Methylene Chloride	5	0.79	J	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
trans-1,2-Dichloroethene	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Methyl tert-Butyl Ether	10	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1-Dichloroethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
2-Butanone	50	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Chloroform	7	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,1-Trichloroethane	5	0.5	U	0.66		0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Benzene	1	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
cis-1,3-Dichloropropene	0.4	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Toluene	5	0.56	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Ethylbenzene	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Xylenes (total)	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,4-Dichlorobenzene	3	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (µg/L)
Site-related VOCs are bolded
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-4
Multi-Port Well VOC Results - Round 1
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-8 Port 1 435 to 440 ft GWM-08-1		Port 2 370 to 375 ft GWM-08-2		Port 3 235 to 240 ft GWM-08-3		Port 4 155 to 160 ft GWM-08-4		Port 5 100 to 105 ft GWM-08-5		Port 6 45 to 50 ft GWM-08-6	
Tetrachloroethene	**5**	**1.9**		**1.9**		**15**		**17**		**34**		**0.92**	
Trichloroethene	**5**	**1.9**		**1.5**		**1.2**		**1**		**1.6**		**0.5**	**U**
1,1-Dichloroethene	**5**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**
cis-1,2-Dichloroethene	**5**	**0.21**	**J**	**0.18**	**J**	**0.5**	**U**	**0.5**	**U**	**0.18**	**J**	**0.5**	**U**
Carbon Tetrachloride	**5**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**
Dichlorodifluoromethane	5	0.5	U	0.33	J	0.5	U	0.5	U	0.5	U	0.5	U
Chloromethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Chloroethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Trichlorofluoromethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Acetone	50	5	U	5	U	5	U	5	U	5	U	5	U
Carbon Disulfide	50	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Methylene Chloride	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
trans-1,2-Dichloroethene	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Methyl tert-Butyl Ether	10	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1-Dichloroethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
2-Butanone	50	5	U	5	U	5	U	5	U	5	U	5	U
Chloroform	7	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,1-Trichloroethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Benzene	1	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
cis-1,3-Dichloropropene	0.4	0.5	U	0.5	U	0.5	U	0.5	U	0.13	J	0.5	U
Toluene	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Ethylbenzene	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Xylenes (total)	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,4-Dichlorobenzene	3	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (µg/L)
Site-related VOCs are bolded
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-5
Multi-Port Well VOC Results - Round 2
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-1 (background) Port 2 400 to 405 ft GWM-01-2	Port 3 370 to 375 ft GWM-01-3	Port 4 315 to 320 ft GWM-01-4	Port 5 290 to 295 ft GWM-01-5	Port 6 250 to 255 ft GWM-01-6	Port 7 200 to 205 ft GWM-01-7	Port 8 150 to 155 ft GWM-01-8	Port 9 100 to 105 ft GWM-01-9	Port 10 50 to 55 ft GWM-01-10
Tetrachloroethene	**5**	**0.7**	**0.8**	**0.8**	**0.21 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Trichloroethene	**5**	**0.99**	**2.4**	**0.92**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
1,1-Dichloroethene	**5**	**0.5 U**	**4**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**0.13 J**	**0.22 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Carbon Tetrachloride	**5**	**0.5 U**	**0.49 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	0.5 R	0.5 U	0.5 R	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	1	4.2	16	20	10	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5 U	0.5 U	0.5 U	0.72	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	1.6 J	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Disulfide	50	0.5 R	0.5 U	0.5 R	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl Acetate	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	0.5 U	0.78	0.5 U	0.8 U	0.94 U	0.97 U	0.85 U	0.76 U	0.76 U
trans-1,2-Dichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.39 J	1.1	9.9	8.1	1.8	0.15 J	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	5	5.6	9.4	3.8	0.81	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	1.7	3.7	0.8	0.18 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.05 J	0.5 U	0.5 U
2-Hexanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	2.2 J	5 U
Dibromochloromethane	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
m,p-Xylenes	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-chloropropane	0.04	0.5 U	0.47 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dioxane	N/A	2 R	2 R	2 R	2 R	2 R	2 R	2 R	2 R	2 R

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (µg/L)
Data for SVP-1 Port 1 is not available because a sample was not able to be collected during Round 1
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-5
Multi-Port Well VOC Results - Round 2
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-2 Port 1 450 to 455 ft GWM-02-1	Port 2 410 to 415 ft GWM-02-2	Port 3 370 to 375 ft GWM-02-3	Port 4 330 to 335 ft GWM-02-4	Port 5 290 to 295 ft GWM-02-5	Port 6 250 to 255 ft GWM-02-6	Port 7 190 to 195 ft GWM-02-7	Port 8 150 to 155 ft GWM-02-8	Port 9 100 to 105 ft GWM-02-9	Port 10 50 to 55 ft GWM-02-10
Tetrachloroethene	**5**	**1.8**	**2.3**	**4.4**	**2.6**	**2.2**	**4.3**	**2.3**	**2.3**	**0.38 J**	**0.14 J**
Trichloroethene	**5**	**15**	**17**	**38 J**	**21**	**23 J**	**17**	**12**	**18**	**18**	**1**
1,1-Dichloroethene	**5**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**0.74**	**4.1**	**10**	**5.8**	**5.7**	**10**	**0.34 J**	**0.48 J**	**0.76**	**0.14 J**
Carbon Tetrachloride	**5**	**0.03 J**	**0.5 U**	**0.5 U**	**0.06 J**	**0.07 J**	**0.13 J**	**0.1 J**	**0.06 J**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	3	8.2	0.5 U	0.39 J	0.44 J	0.5 U	0.5 U	0.5 U	0.1 J	0.1 J
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Disulfide	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl Acetate	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	0.89 U	0.88 U	1.3 U	0.73 U	1.6 U	0.93	0.61 U	0.62 U	1.9 U	4.1
trans-1,2-Dichloroethene	5	0.5 U	0.22 J	0.58	0.35 J	0.24 J	0.84	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.97	0.54	1.1	0.58	0.67	1.1	0.72	1.4	4.6	0.5 U
1,1-Dichloroethane	5	0.5 U	0.87	0.38 J	0.19 J	0.17 J	0.33 J	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	60	68	5 U	5 U	5 U
Chloroform	7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.27 J	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.15 J	0.5 U	0.5 U	0.07 J	0.5 U
1,2-Dichloroethane	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	50	5 U	5 U	5 U	3.2 J	5 U	5 U	5 U	5 U	5 U	2.8 J
Dibromochloromethane	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
m,p-Xylenes	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-chloropropane	0.04	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dioxane	N/A	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 R

Notes:

SSGWSC = Site-specific groundwater screening criteria

All results in micrograms per liter (μg/L)

Data for SVP-1 Port 1 is not available because a sample was not able to be collected during Round 1

U = undetected

J = Result is estimated due to exceeded quality control criteria

R = Result is rejected

ft = feet below ground surface

LDL VOC = low detection limit volatile organic compounds

Table 1-5
Multi-Port Well VOC Results - Round 2
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-3 Port 1 450 to 455 ft GWM-03-1	GWM-3 Port 2 390 to 395 ft GWM-03-2	GWM-3 Port 3 370 to 375 ft GWM-03-3	GWM-3 Port 4 290 to 295 ft GWM-03-4	GWM-3 Port 5 170 to 175 ft GWM-03-5	GWM-3 Port 6 100 to 105 ft GWM-03-6	GWM-3 Port 7 50 to 55 ft GWM-03-7
Tetrachloroethene	**5**	**0.5 U**	**0.5 U**	**0.3 J**	**0.24 J**	**0.46 J**	**0.64**	**0.54**
Trichloroethene	**5**	**6.1**	**14**	**13**	**0.51**	**1**	**0.5 U**	**0.5 U**
1,1-Dichloroethene	**5**	**0.5 U**	**1**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**0.12 J**	**0.8**	**0.61**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Carbon Tetrachloride	**5**	**0.5 U**	**0.21 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.12 J**	**0.07 J**
Dichlorodifluoromethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	52	15	9.2	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	3.1 J	5 U	5 U	5 U	5 U	4.2 J	5 U
Carbon Disulfide	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl Acetate	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	0.54 U	1.4 U	1 U	1.3 U	1.4 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.5 U	0.5 U	0.5 U	0.5 U	4.7	0.33 J	0.5 U
1,1-Dichloroethane	5	1.1	5.8	3.3	0.5 U	1.5	0.28 J	0.5 U
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	0.26 J	1.4	0.93	0.5 U	0.5 U	0.77	0.63
Benzene	1	0.5 U	0.5 U	0.5 U	0.5 U	0.17 J	0.5 U	0.5 U
1,2-Dichloroethane	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.04 J	0.5 U	0.5 U	0.5 U	0.04 J	0.5 U
1,1,2-Trichloroethane	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	0.02 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
m,p-Xylenes	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.05 J	0.5 U
1,2-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-chloropropane	0.04	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dioxane	N/A	2 R	2 R	2 R	2 R	2 R	2 R	2 R

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (µg/L)
Data for SVP-1 Port 1 is not available because a sample was not able to be collected during Round 1
U = undetected
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ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-5
Multi-Port Well VOC Results - Round 2
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-4 Port 1 420 to 425 ft GWM-04-1	Port 2 400 to 405 ft GWM-04-2	Port 3 350 to 355 ft GWM-04-3	Port 4 305 to 310 ft GWM-04-4	Port 5 285 to 290 ft GWM-04-5	Port 6 245 to 250 ft GWM-04-6	Port 7 185 to 190 ft GWM-04-7	Port 8 145 to 150 ft GWM-04-8	Port 9 100 to 105 ft GWM-04-9	Port 10 45 to 50 ft GWM-04-10
Tetrachloroethene	**5**	**21 J**	**29**	**210**	**200**	**100**	**94**	**25**	**16**	**14**	**0.31 J**
Trichloroethene	**5**	**21 J**	**22**	**180**	**200**	**130**	**94**	**120**	**16**	**2.9**	**1.6**
1,1-Dichloroethene	**5**	**5.8**	**4**	**9.7**	**4.8**	**3.4**	**2**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**2.2 J**	**2.9**	**11 J**	**5**	**4.7**	**7.8**	**2.7**	**1.4**	**0.62**	**0.13 J**
Carbon Tetrachloride	**5**	**1.8**	**2.9**	**0.29 J**	**0.12 J**	**0.08 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	0.5 U	0.5 U	11 J	13	12	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	14	9.6	0.5 U	0.5 U	0.11 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Disulfide	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl Acetate	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	1.2	3	1.4	1.3	1.4	1.2 U	0.5 U	1.7 U	0.86 U	0.5 U
trans-1,2-Dichloroethene	5	0.5 R	0.5 U	0.45 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	3	2.5	15	13	18	21	26 J	9.9	0.5 U	0.5 U
1,1-Dichloroethane	5	6	3.3	1.1	0.52	0.49 J	0.54	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	17	5 U	5 U	5 U	5 U
Chloroform	7	3.8	2.3	0.53	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	2.6	1.7	2.7	1.7	1.2	0.89	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	1	0.5 U	0.5 U	0.7	0.43 J	0.36 J	0.58	0.32 J	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.96	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.5 U	0.5 U	0.04 J	0.5 U	0.35 J	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	50	0.5 U	0.5 U	0.5 U	0.5 U	0.07 J	0.5 U	0.5 U	0.5 U	0.5 U	0.47 J
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.07 J	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.08 J	0.5 U	0.5 U	0.5 U	0.5 U
m,p-Xylenes	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.21 J	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.06 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-chloropropane	0.04	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dioxane	N/A	2 R	2 R	2 R	2 R	2 R	2 R	2 R	2 R	2 R	2 R

Notes:
SSGWSC = Site-specific groundwater screening criteria
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Data for SVP-1 Port 1 is not available because a sample was not able to be collected during Round 1
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ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-5
Multi-Port Well VOC Results - Round 2
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name		GWM-5									
		Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10
		430 to 435 ft	405 to 410 ft	355 to 360 ft	310 to 315 ft	290 to 295 ft	250 to 255 ft	190 to 195 ft	150 to 155 ft	95 to 100 ft	45 to 50 ft
LDL VOCs	**SSGWSC**	**GWM-05-1**	**GWM-05-2**	**GWM-05-3**	**GWM-05-4**	**GWM-05-5**	**GWM-05-6**	**GWM-05-7**	**GWM-05-8**	**GWM-05-9**	**GWM-05-10**
Tetrachloroethene	**5**	**0.35 J**	**0.92**	**0.63**	**0.73**	**0.6**	**0.72**	**0.4 J**	**0.49 J**	**0.11 J**	**0.37 J**
Trichloroethene	**5**	**9.3**	**28**	**14**	**18**	**18**	**12**	**2.1**	**1.7**	**0.19 J**	**1.6**
1,1-Dichloroethene	**5**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**1.4**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**1.1**	**2.9**	**1.8**	**2**	**2**	**1.8**	**0.26 J**	**0.25 J**	**0.5 U**	**0.18 J**
Carbon Tetrachloride	**5**	**0.43 J**	**0.87**	**0.19 J**	**0.11 J**	**0.12 J**	**0.5 U**	**0.12 J**	**0.16 J**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	0.5 U	1.8	0.5 U	0.5 U	0.64	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.08 J	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Disulfide	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl Acetate	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.55 U	0.5 U
trans-1,2-Dichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.5 U	0.5 U	0.95	1.6	1.2	0.98	0.49 J	1.1	0.5 U	0.99
1,1-Dichloroethane	5	0.5 U	0.62	1.7	2.3	1.6	1.4	2.7	3.1	0.5 U	1
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	0.5 U	0.16 J	0.05 J	0.17 J	0.2 J	0.49 J	0.97	0.85	0.5 U	0.29 J
Benzene	1	0.5 U	0.5 U	0.13 J	0.03 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.06 J	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
m,p-Xylenes	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.27 J	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-chloropropane	0.04	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dioxane	N/A	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U

Notes:

SSGWSC = Site-specific groundwater screening criteria

All results in micrograms per liter (µg/L)

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Table 1-5
Multi-Port Well VOC Results - Round 2
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name		GWM-6											
		Port 1		Port 2		Port 3		Port 4		Port 5		Port 6	
		445 to 450 ft		365 to 370 ft		245 to 250 ft		175 to 180 ft		100 to 105 ft		45 to 50 ft	
LDL VOCs	SSGWSC	GWM-06-1		GWM-06-2		GWM-06-3		GWM-06-4		GWM-06-5		GWM-06-6	
Tetrachloroethene	**5**	**0.5**	**U**	**0.5**	**U**	**0.29**	**J**	**0.24**	**J**	**0.54**		**0.087**	**J**
Trichloroethene	**5**	**1.4**		**0.5**	**U**	**2.3**		**1**		**2.5**		**0.5**	**U**
1,1-Dichloroethene	**5**	**0.5**	**U**	**0.5**	**U**	**9.7**		**6.7**		**16**		**0.5**	**U**
cis-1,2-Dichloroethene	**5**	**0.67**		**0.19**	**J**	**5.9**	**J**	**3.7**	**J**	**17**	**J**	**0.5**	**U**
Carbon Tetrachloride	**5**	**0.06**	**J**	**0.5**	**U**	**0.5**	**U**	**0.29**	**J**	**1**		**0.5**	**U**
Dichlorodifluoromethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Trichlorofluoromethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.22	J	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Acetone	50	5	U	5	U	8.2		5	U	5	U	130	
Carbon Disulfide	50	0.5	U	0.47	J	0.36	J	0.37	J	0.5	U	0.37	J
Methyl Acetate	NA	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	6.7	
Methylene Chloride	5	1		0.5	U	0.5	U	0.5	U	1.5	U	0.5	U
trans-1,2-Dichloroethene	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Methyl tert-Butyl Ether	10	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1-Dichloroethane	5	0.5	U	0.17	J	9.5		9.3		25	J	0.5	U
2-Butanone	50	5	U	5	U	2.1	J	5	U	5	U	22	
Chloroform	7	0.58	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,1-Trichloroethane	5	0.57		0.22	J	0.22	J	1.8		6.1		0.47	J
Benzene	1	0.5	U	0.5	U	0.5	U	0.063	J	0.5	U	0.5	U
1,2-Dichloroethane	0.6	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
cis-1,3-Dichloropropene	0.4	0.5	U	0.5	U	0.17	J	0.5	U	0.5	U	0.5	U
Toluene	5	0.5	U	0.5	U	800		0.79		0.69		270	
1,1,2-Trichloroethane	1	0.5	U	0.5	U	0.5	UJ	0.5	U	0.5	U	0.5	U
2-Hexanone	50	5	U	5	U	5	U	5	U	5	U	5	U
Dibromochloromethane	50	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Ethylbenzene	5	0.5	U	0.5	U	0.23	J	0.089	J	0.5	U	0.42	J
o-Xylene	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
m,p-Xylenes	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Bromoform	50	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,3-Dichlorobenzene	3	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.026	J
1,4-Dichlorobenzene	3	0.5	U	0.5	U	0.11	J	0.5	U	0.5	U	1.7	
1,2-Dichlorobenzene	3	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.042	J
1,2-Dibromo-3-chloropropane	0.04	0.5	U	0.5	U	0.5	UJ	0.5	U	0.5	U	0.5	U
1,4-Dioxane	N/A	2	U	2	U	2.4		2	U	6		2	U

Notes:

SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (µg/L)
Data for SVP-1 Port 1 is not available because a sample was not able to be collected during Round 1
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-5
Multi-Port Well VOC Results - Round 2
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-7 Port 1 445 to 450 ft GWM-07-1		Port 2 425 to 430 ft GWM-07-2		Port 3 310 to 315 ft GWM-07-3		Port 4 205 to 210 ft GWM-07-4		Port 5 100 to 105 ft GWM-07-5		Port 6 45 to 50 ft GWM-07-6	
Tetrachloroethene	**5**	**0.5**	**U**	**0.5**	**U**	**7.7**		**0.56**		**0.69**		**0.5**	**U**
Trichloroethene	**5**	**0.24**	**J**	**6.2**		**20**		**0.81**		**1.8**		**0.5**	**U**
1,1-Dichloroethene	**5**	**0.5**	**U**	**5.2**		**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**
cis-1,2-Dichloroethene	**5**	**0.5**	**U**	**0.76**		**3.9**		**0.5**	**U**	**0.5**	**U**	**0.5**	**U**
Carbon Tetrachloride	**5**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**	**0.5**	**U**
Dichlorodifluoromethane	5	0.5	U	0.5	R	0.5	U	0.5	U	0.5	U	0.5	U
Trichlorofluoromethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Acetone	50	5	U	2	J	5	U	5	U	5	U	5	U
Carbon Disulfide	50	0.5	U	0.5	R	0.5	U	0.5	U	0.5	U	0.5	U
Methyl Acetate	NA	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Methylene Chloride	5	1.7	U	0.57		0.5	U	1.2	U	0.5	U	0.5	U
trans-1,2-Dichloroethene	5	0.5	U	0.5	U	0.07	J	0.5	U	0.5	U	0.5	U
Methyl tert-Butyl Ether	10	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1-Dichloroethane	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
2-Butanone	50	5	U	5	U	5	U	5	U	5	U	5	U
Chloroform	7	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,1,1-Trichloroethane	5	0.5	U	1.6		0.5	U	0.5	U	0.5	U	0.5	U
Benzene	1	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichloroethane	0.6	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
cis-1,3-Dichloropropene	0.4	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Toluene	5	0.5	U	0.5	U	0.04	J	0.5	U	0.5	U	0.5	U
1,1,2-Trichloroethane	1	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
2-Hexanone	50	5	U	5	U	5	U	5	U	5	U	5	U
Dibromochloromethane	50	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Ethylbenzene	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
o-Xylene	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
m,p-Xylenes	5	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Bromoform	50	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,3-Dichlorobenzene	3	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,4-Dichlorobenzene	3	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dichlorobenzene	3	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,2-Dibromo-3-chloropropane	0.04	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
1,4-Dioxane	N/A	2	R	2	R	2	R	2	R	2	R	2	R

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (µg/L)
Data for SVP-1 Port 1 is not available because a sample was not able to be collected during Round 1
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-5
Multi-Port Well VOC Results - Round 2
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWM-8 Port 1 435 to 440 ft GWM-08-1	Port 2 370 to 375 ft GWM-08-2	Port 3 235 to 240 ft GWM-08-3	Port 4 155 to 160 ft GWM-08-4	Port 4 155 to 160 ft Duplicate	Port 5 100 to 105 ft GWM-08-5	Port 6 45 to 50 ft GWM-08-6
Tetrachloroethene	**5**	**6.7**	**13**	**23**	**23**	**40**	**57**	**0.35 J**
Trichloroethene	**5**	**1.4**	**3.2**	**1.1**	**1.6**	**1**	**2**	**0.5 U**
1,1-Dichloroethene	**5**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**0.5 U**	**0.46 J**	**0.5 U**	**0.5 U**	**0.16 J**	**0.3 J**	**0.5 U**
Carbon Tetrachloride	**5**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Carbon Disulfide	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl Acetate	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene Chloride	5	0.5 U	0.5 U	0.5 U	0.63 U	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Dibromochloromethane	50	0.5 U	0.5 U	0.5 U	0.5 U	0.16 J	0.5 U	0.5 U
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
o-Xylene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
m,p-Xylenes	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	50	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-chloropropane	0.04	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dioxane	N/A	2 U	2 U	2 U	2 U	2 U	2 U	2 R

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (µg/L)
Data for SVP-1 Port 1 is not available because a sample was not able to be collected during Round 1
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compounds

Table 1-6
Existing Well and Supply Well VOC Results - Round 1
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name		GWP-10	GWP-11	GWP-11-Dup	GWX-10019	GWX-10020	GWX-10035	GWX-8474	GWX-8475	GWX-9398	GWX-9966	GWX-9953
LDL VOCs	SSGWSC	377-417 ft	370-410 ft		223 to 228 ft	185 to 190 ft	48 to 53 ft	485 to 556 ft	409 to 481 ft	21 to 22 ft	38 to 51 ft	35 to 40 ft
Tetrachloroethene	**5**	**270**	**50**	**50**	**2**	**1.3**	**0.5 U**	**5.8**	**5.5**	**0.16 J**	**0.5 U**	**0.5 U**
Trichloroethene	**5**	**170**	**160**	**160**	**260**	**1.6**	**1.2**	**29**	**24**	**0.5 U**	**0.5 U**	**0.5 U**
1,1-Dichloroethene	**5**	**5.5**	**4**	**4.2**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**17**	**0.5 U**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**13**	**13**	**14**	**21**	**0.19 J**	**0.5 U**	**0.76**	**1.2**	**0.5 U**	**0.5 U**	**0.5 U**
Carbon Tetrachloride	**5**	**0.85**	**0.42 J**	**0.43 J**	**0.2 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	9.4	20	21	0.62	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	2.4	1.5	1.6	1.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethan	5	0.5 U	0.28 J	0.3 J	0.5 U	0.5 U	0.5 U	0.48 J	2.3	0.5 U	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	2.3 J
Methylene Chloride	5	0.5 U	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	5	0.31 J	0.18 J	0.22 J	0.3 J	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.31 J	0.5 U	0.11 J	17	1.7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.2
1,1-Dichloroethane	5	1.5	0.73	0.73	0.18 J	0.5 U	0.5 U	0.39 J	0.7	0.5 U	0.5 U	0.5 U
Chloroform	7	1.2	0.5 U	0.5 U	0.29 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	2.6	2.1	2.3	0.5 U	0.5 U	0.5 U	0.93	5.3	0.5 U	0.5 U	0.5 U
Benzene	1	0.25 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.6	0.5 U	0.5 U	0.5 U	1.3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	0.5 U	0.5 U	0.5 U	0.11 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	0.19 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (μg/L)
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compound

Table 1-7
Existing Well and Supply Well VOC Results - Round 2
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Chemical Name LDL VOCs	SSGWSC	GWP-10 377-417 ft	GWP-11 370-410 ft	GWP-11-Dup	GWX-10019 223 to 228 ft	GWX-10020 185 to 190 ft	GWX-10035 48 to 53 ft	GWX-8086 265-291 ft	GWX-8474 485 to 556 ft	GWX-8475 409 to 481 ft	GWX-9398 21 to 22 ft	GWX-9966 38 to 51 ft	GWX-9953 35 to 40 ft
Tetrachloroethene	**5**	**230**	**58**	**48**	**2.2**	**0.5 U**	**0.5 U**	**170**	**6.3**	**3.7**	**0.5 U**	**0.5 U**	**0.5 U**
Trichloroethene	**5**	**220**	**160**	**120**	**170**	**0.14 J**	**0.31 J**	**54**	**25**	**16**	**0.5 U**	**0.5 U**	**0.5 U**
1,1-Dichloroethene	**5**	**12**	**3.7**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**	**17**	**7.4**	**20 J**	**0.5 U**	**0.5 U**	**0.5 U**
cis-1,2-Dichloroethene	**5**	**26 J**	**10**	**15**	**23**	**0.5 U**	**0.5 U**	**5.3 J**	**1.4 J**	**0.79 J**	**0.5 U**	**0.5 U**	**0.5 U**
Carbon Tetrachloride	**5**	**1.2**	**0.46 J**	**0.33 J**	**0.28 J**	**0.5 U**	**0.5 U**	**0.44 J**	**0.42 J**	**0.5 U**	**0.5 U**	**0.5 U**	**0.5 U**
Dichlorodifluoromethane	5	21	0.5 U	3.9 U	0.75 U	4 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane	5	3.9	1.3	0.5 U	1.9	0.5 U	0.5 U	1.2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5.5	1.2	4.9	0.5 U	0.5 U	0.5 U
Acetone	50	5 U	5 U	5 U	5 U	7.7 J	2.8 J	5 U	5 U	5 U	5 U	5 U	5 U
Methylene Chloride	5	2.4 U	0.72 U	4.2 U	0.84 U	4.8 U	0.91 U	0.5 U	0.52 U	0.64 U	2.4	0.52 U	2.2
trans-1,2-Dichloroethene	5	0.64 J	0.06 J	0.2 J	0.24 J	0.5 U	0.5 U	0.07 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-Butyl Ether	10	0.77	0.5 U	0.5 U	24	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	5.3
1,1-Dichloroethane	5	2.5	0.74	0.98	0.22 J	0.5 U	0.5 U	1.2	0.48 J	0.75	0.5 U	0.5 U	0.5 U
Chloroform	7	1.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	3.8	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,1-Trichloroethane	5	4.8	2	2	0.5 U	0.5 U	0.5 U	4.1	2.7	6.9	0.5 U	0.5 U	0.5 U
Benzene	1	0.32 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	0.28 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.18 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Hexanone	50	5 U	5 U	5 U	5 U	5 U	5 U	5 U	3 J	5 U	5 U	5 U	5 U
Ethylbenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.03 J	0.5 U
o-Xylene	N/A	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	0.5 U
1,3-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 R	0.5 U	0.5 U	0.5 U	0.5 U	0.02 J	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	0.5 U	0.5 U	0.5 U	0.5 R	0.5 U	0.5 U	0.5 U	0.5 U	0.02 J	0.5 U	0.5 U	0.5 U

Notes:
SSGWSC = Site-specific groundwater screening criteria
All results in micrograms per liter (µg/L)
U = undetected
J = Result is estimated due to exceeded quality control criteria
R = Result is rejected
ft = feet below ground surface
LDL VOC = low detection limit volatile organic compound

Table 1-8
TO-15 VOC Results - Outdoor Building Soil Gas Samples
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Contaminant	Screening Criteria (1)	SGRF-01 12/20/2005	SGRF-02 12/20/2005	SGRF-03 12/20/2005	SGRF-04 12/21/2005	SGRF-05 12/21/2005	SGRF-06 12/21/2005	SGRF-07 12/22/2005	SGRF-08 12/22/2005	SGRF-08-Dup 12/22/2005	SGRF-12 12/23/2005
Tetrachloroethene	**81**	**6.6 U**	**6.8 U**	**6.5 U**	**6.5 U**	**6.4 U**	**6.5 U**	**6.6 U**	**7.1 U**	**7.3 U**	**6.7 U**
Trichloroethene	**2.2**	**5.2 U**	**5.4 U**	**5.2 U**	**5.2 U**	**5.1 U**	**5.2 U**	**5.2 U**	**5.6 U**	**5.8 U**	**5.3 U**
1,1-Dichloroethene	**20,000**	**3.8 U**	**4 U**	**3.8 U**	**3.8 U**	**3.7 U**	**3.8 U**	**3.8 U**	**4.1 U**	**4.3 U**	**3.9 U**
cis-1,2-Dichloroethene	**3,500**	**3.8 U**	**4 U**	**3.8 U**	**3.8 U**	**3.7 U**	**3.8 U**	**3.8 U**	**4.1 U**	**4.3 U**	**3.9 U**
Carbon Tetrachloride	**18**	**6.1 U**	**6.4 U**	**6 U**	**6 U**	**5.9 U**	**6 U**	**6.1 U**	**6.6 U**	**6.8 U**	**6.2 U**
Dichlorodifluoromethane	20,000	4.8 U	5 U	4.7 U	4.7 U	4.7 U	4.7 U	4.8 U	5.2 U	5.3 U	4.9 U
Chloromethane	NA	8 U	8.3 U	7.9 U	7.9 U	7.8 U	7.9 U	8 U	8.6 U	8.9 U	8.1 U
1,3-Butadiene	0.87	2.1 U	2.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.3 U	2.4 U	2.2 U
Trichlorofluoromethane	70,000	1.4 J	5.7 U	5.4 U	1.3 J	1.7 J	5.4 U	5.4 U	5.9 U	6.1 U	5.5 U
Ethanol	NA	7.3 U	6.1 J	12	8.1	9.4	7.7	9.1	12	9.6	6.9 J
1,1,2-Trichloro-1,2,2-trifluoroethane	3,000,000	7.4 U	7.7 U	7.4 U	7.4 U	7.2 U	7.4 U	7.4 U	8 U	8.3 U	7.5 U
Acetone	35,000	9 J	7.1 J	30	28	13	18	15	22	10	8.4 J
Isopropyl Alcohol	NA	9.5 U	1.1 J	3.4 J	9.4 U	9.3 U	9.4 U	9.5 U	10 U	11 U	9.7 U
Carbon Disulfide	70,000	3 U	3.1 U	4.4	3 U	0.98 J	1.4 J	0.92 J	0.94 J	3.4 U	3.1 U
Methylene Chloride	520	3.4 U	3.5 U	3.3 U	3.3 U	3.3 U	0.99 J	3.4 U	3.6 U	3.8 U	3.4 U
Methyl tert-Butyl Ether	300,000	3.5 U	3.6 U	3.5 U	3.5 U	3.4 U	3.5 U	3.5 U	3.8 U	3.9 U	3.6 U
Hexane	20,000	3.4 U	1.2 J	8.6	2 J	1.4 J	1.1 J	2.8 J	2 J	1.9 J	3.5 U
1,1-Dichloroethane	50,000	3.9 U	4.1 U	3.9 U	3.9 U	3.8 U	3.9 U	3.9 U	4.2 U	4.4 U	4 U
2-Butanone	NA	2.9 U	3 U	5.1	1.2 J	1.1 J	0.95 J	1.3 J	2.5 J	3.2 U	1.2 J
Tetrahydrofuran	NA	3.4	2.1 J	2.7 J	1.9 J	1.9 J	2.8 U	2.9 U	3.1 U	3.2 U	2.9 U
Chloroform	11	4.7 U	4.9 U	4.7 U	4.7 U	4.6 U	4.7 U	4.7 U	5.1 U	5.3 U	4.8 U
1,1,1-Trichloroethane	220,000	5.3 U	5.5 U	5.2 U	5.2 U	5.2 U	5.2 U	5.3 U	5.7 U	5.9 U	5.4 U
Cyclohexane	NA	3.3 U	3.5 U	3.3 U	3.3 U	3.2 U	3.3 U	3.3 U	3.6 U	3.7 U	3.4 U
2,2,4-Trimethylpentane	NA	4.5 U	4.7 U	4.5 U	4.5 U	4.4 U	4.5 U	4.5 U	4.9 U	5 U	4.6 U
Benzene	31	1.6 J	1.5 J	3.5	2.9 J	1.6 J	1.6 J	1.6 J	2.2 J	1.8 J	1.8 J
1,2-Dichloroethane	9.4	3.9 U	4.1 U	3.9 U	3.9 U	3.8 U	3.9 U	3.9 U	4.2 U	4.4 U	4 U
n-Heptane	NA	4 U	4.1 U	5.1	3.9 U	3.9 U	3.9 U	4 U	4.3 U	4.4 U	4 U
1,4-Dioxane	NA	14 U	14 U	14 U	14 U	14 U	14 U	14 U	15 U	16 U	14 U
Toluene	40,000	3 J	2.9 J	3.6	3.6	2.7 J	3.2 J	3.2 J	4.5	3.9 J	2.2 J
2-Hexanone	NA	16 U	16 U	16 U	16 U	15 U	16 U	16 U	17 U	18 U	16 U
Ethylbenzene	220	4.2 U	4.4 U	4.2 U	4.2 U	4.1 U	4.2 U	4.2 U	4.5 U	4.7 U	4.3 U
m-Xylene	700,000	4.2 U	4.4 U	3.6 J	1.7 J	1.7 J	1.7 J	1.9 J	2.8 J	2.3 J	4.3 U
o-Xylene	700,000	4.2 U	4.4 U	2.1 J	4.2 U	4.1 U	4.2 U	4.2 U	4.5 U	4.7 U	4.3 U
n-Propylbenzene	14,000	4.8 U	5 U	0.95 J	4.7 U	4.6 U	4.7 U	4.8 U	5.1 U	5.3 U	4.8 U
4-Ethyltoluene	NA	4.8 U	5 U	3.2 J	4.7 U	4.6 U	4.7 U	4.8 U	5.1 U	5.3 U	4.8 U
1,3,5-Trimethylbenzene	600	4.8 U	5 U	1 J	4.7 U	4.6 U	4.7 U	4.8 U	5.1 U	5.3 U	4.8 U
1,2,4-Trimethylbenzene	600	4.8 U	5 U	3.6 J	4.7 U	4.6 U	4.7 U	4.8 U	5.1 U	5.3 U	4.8 U

Notes:

All values are in micrograms per cubic meter (µg/m3)
(1) EPA Draft Document for Evaluating the Vapor Intrusion to
Indoor Air Pathway from Groundwater and Soils, November 2002
Table 2C, deep soil gas
SGRF-10 and SGRF-11 were not collected due to underground utilities
NA = not available
U = non-detect
J = estimated value
R = rejected

Table 1-8
TO-15 VOC Results - Outdoor Building Soil Gas Samples
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Contaminant	Screening Criteria (1)	SGRF-13 12/23/2005	SGRF-14 12/23/2005	SGRF-15 12/23/2005	SGRF-16 1/5/2006	SGRF-17 1/5/2006	SGRF-18 1/5/2006	SGRF-19 1/5/2006	SGRF-20 1/5/2006	SGRF-21 1/5/2006	SGRF-22 1/5/2006
Tetrachloroethene	**81**	**6.7 U**	**6.8 U**	**7 U**	**7.3 U**	**2.3 J**	**6.7 U**	**7.1 U**	**7.1 U**	**7.2 U**	**6.8 U**
Trichloroethene	**2.2**	**5.3 U**	**5.4 U**	**5.5 U**	**5.8 U**	**1.5 J**	**5.3 U**	**5.6 U**	**5.6 U**	**5.7 U**	**5.4 U**
1,1-Dichloroethene	**20,000**	**3.9 U**	**4 U**	**4.1 U**	**4.3 U**	**3.9 U**	**3.9 U**	**4.2 U**	**4.1 U**	**4.2 U**	**4 U**
cis-1,2-Dichloroethene	**3,500**	**3.9 U**	**4 U**	**4.1 U**	**4.3 U**	**3.9 U**	**3.9 U**	**4.2 U**	**4.1 U**	**4.2 U**	**4 U**
Carbon Tetrachloride	**18**	**6.3 U**	**6.4 U**	**6.4 U**	**6.8 U**	**6.2 U**	**6.2 U**	**6.6 UJ**	**6.6 UJ**	**6.7 UJ**	**6.4 UJ**
Dichlorodifluoromethane	20,000	4.9 U	5 U	5.1 U	2.5 J	2.8 J	2.8 J	5.2 U	2.8 J	2.8 J	2.8 J
Chloromethane	NA	8.2 U	8.3 U	8.5 U	8.9 U	2.5 J	3.6 J	2.4 J	1.9 J	1.7 J	2.2 J
1,3-Butadiene	0.87	2.2 U	2.2 U	2.3 U	2.4 U	4	2.2 U	3.3 J	9.9 J	7.2 J	2.4 J
Trichlorofluoromethane	70,000	5.6 U	5.7 U	5.8 U	6.1 U	5.5 U	5.5 U	5.9 U	5.9 U	6 U	5.7 U
Ethanol	NA	8.8	13	18	4.1 J	8.4 J	6.1 J	10	15	11	14
1,1,2-Trichloro-1,2,2-trifluoroethane	3,000,000	7.6 U	7.7 U	7.8 U	8.3 U	7.5 U	7.5 U	8 U	8 U	8.2 U	7.7 U
Acetone	35,000	7.8 J	6.9 J	35	10 U	16 U	9.4 U	15	18	12	18
Isopropyl Alcohol	NA	9.8 U	9.9 U	2.7 J	11 U	1.4 J	65	1.5 J	2.6 J	3.5 J	2.3 J
Carbon Disulfide	70,000	3.1 U	3.1 U	3.2 U	0.47 J	19	3.1 U	0.8 J	2.8 J	1.9 J	0.72 J
Methylene Chloride	520	1.3 J	3.5 U	1.1 J	3.8 U	1.3 J	3.4 U	3.6 U	3.6 U	3.7 U	3.5 U
Methyl tert-Butyl Ether	300,000	3.6 U	3.6 U	0.97 J	3.9 UJ	3.6 UJ	3.6 UJ	3.8 U	0.95 J	1.3 J	1.4 J
Hexane	20,000	1.3 J	1.4 J	2.1 J	3.8 U	3.1 J	3.5 U	3.5 J	5	4.1	1.5 J
1,1-Dichloroethane	50,000	4 U	4.1 U	4.1 U	4.4 U	4 U	4 U	4.2 U	4.2 U	4.3 U	4.1 U
2-Butanone	NA	1.6 J	1 J	7.5	0.96 J	3.1	1.4 J	3.1	4.2	3 J	3 J
Tetrahydrofuran	NA	1.8 J	3 U	2 J	3.2 U	2.9 U	2.9 U	3.1 U	3.1 U	3.1 U	3 U
Chloroform	11	4.8 U	4.9 U	5 U	5.3 U	4.8 U	4.8 U	5.1 U	5.1 U	5.2 U	4.9 U
1,1,1-Trichloroethane	220,000	5.4 U	5.5 U	5.6 U	5.9 U	5.4 U	5.4 U	5.7 U	5.7 U	5.8 U	5.5 U
Cyclohexane	NA	3.4 U	3.5 U	3.5 U	3.7 U	3.4 U	3.4 U	3.6 U	3.6 U	3.7 U	3.5 U
2,2,4-Trimethylpentane	NA	4.6 U	4.7 U	0.96 J	5 UJ	4.6 UJ	4.6 UJ	4.9 U	4.9 U	5 U	4.7 U
Benzene	31	2.3 J	2.8 J	2.8 J	2.2 J	3.8	1.5 J	2.6 J	4.2	3.4	2 J
1,2-Dichloroethane	9.4	4 U	4.1 U	4.1 U	4.4 U	4 U	4 U	4.2 U	4.2 U	2.4 J	4.1 U
n-Heptane	NA	4.1 U	4.1 U	4.2 U	4.4 U	3 J	4 U	4.3 U	3.4 J	4.4 U	4.1 U
1,4-Dioxane	NA	14 U	14 U	15 U	16 U	14 U	2.4 J	15 U	15 U	19	14 U
Toluene	40,000	3.1 J	3.9	4.6	2.2 J	5.7	3.7 J	3.9 J	6	8.3	4.7
2-Hexanone	NA	16 U	16 U	1.3 J	18 U	16 U	16 U	17 U	17 U	17 U	16 U
Ethylbenzene	220	4.3 U	4.4 U	4.4 U	4.7 U	4.3 U	4.3 U	4.6 U	4.5 U	4.6 U	4.4 U
m-Xylene	700,000	3.1 J	2.1 J	2.6 J	4.7 U	4.3 U	2.2 J	4.6 U	2.4 J	4.2 J	3.6 J
o-Xylene	700,000	1.3 J	4.4 U	4.4 U	4.7 U	4.3 U	4.3 U	4.6 U	4.5 U	1.5 J	1.5 J
n-Propylbenzene	14,000	4.9 U	5 U	5 U	5.3 U	4.8 U	4.8 U	5.2 U	5.1 U	5.2 U	5 U
4-Ethyltoluene	NA	2.2 J	5 U	5 U	5.3 U	4.8 U	5.2	5.2 U	5.1 U	5.2 U	1.7 J
1,3,5-Trimethylbenzene	600	4.9 U	5 U	5 U	5.3 U	4.8 U	18	5.2 U	5.1 U	5.2 U	5 U
1,2,4-Trimethylbenzene	600	2.9 J	5 U	5 U	5.3 U	4.8 U	4.7 J	5.2 U	5.1 U	5.2 U	2 J

Notes:
All values are in micrograms per cubic meter (µg/m3)
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Indoor Air Pathway from Groundwater and Soils, November 2002
Table 2C, deep soil gas
SGRF-10 and SGRF-11 were not collected due to underground utilities
NA = not available
U = non-detect
J = estimated value
R = rejected

Table 1-8
TO-15 VOC Results - Outdoor Building Soil Gas Samples
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Contaminant	Screening Criteria (1)	SGRF-23 1/5/2006	SGRF-24 1/6/2006	SGRF-25 1/6/2006	SGRF-26 1/6/2006	SGRF-27 1/6/2006	SGRF-28 1/6/2006	SGRF-29 1/6/2006	SGRF-30 1/6/2006	SGRF-31 1/6/2006	SGRF-32 1/6/2006
Tetrachloroethene	**81**	**6.8** U	**7.2** U	**6.7** U	**7.3** U	**6.7** U	**6.7** U	**6.8** U	**6.8** U	**6.7** U	**6.8** U
Trichloroethene	**2.2**	**5.4** U	**5.7** U	**23**	**5.8** U	**5.3** U	**5.3** U	**5.4** U	**5.4** U	**5.3** U	**5.4** U
1,1-Dichloroethene	**20,000**	**4** U	**4.2** U	**3.9** U	**4.3** U	**3.9** U	**3.9** U	**4** U	**4** U	**3.9** U	**4** U
cis-1,2-Dichloroethene	**3,500**	**4** U	**4.2** U	**3.9** U	**4.3** U	**3.9** U	**3.9** U	**4** U	**4** U	**3.9** U	**4** U
Carbon Tetrachloride	**18**	**6.4** UJ	**6.7** U	**6.3** U	**6.8** U	**6.3** U	**6.3** U	**6.4** U	**6.4** U	**6.3** U	**6.4** U
Dichlorodifluoromethane	20,000	2.8 J	5.3 U	4.9 U	5.3 U	4.9 U	4.9 U	5 U	5 U	4.9 U	5 U
Chloromethane	NA	3.2 J	8.8 U	8.2 U	8.9 U	8.2 U	8.2 U	8.3 U	8.3 U	8.2 U	8.3 U
1,3-Butadiene	0.87	2.2 U	2.4 UJ	2.2 UJ	2.4 UJ	2.2 UJ	2.2 UJ	2.2 UJ	2.2 UJ	2.2 UJ	2.2 UJ
Trichlorofluoromethane	70,000	5.7 U	6 U	5.6 U	6.1 U	1.4 J	1.3 J	5.7 U	1.3 J	5.6 U	5.7 U
Ethanol	NA	8.1	5.8 J	7 J	8.2	4.5 J	16	6.6 J	7.2 J	70	3.8 J
1,1,2-Trichloro-1,2,2-trifluoroethane	3,000,000	7.7 U	8.2 U	7.6 U	8.3 U	7.6 U	7.6 U	7.7 U	7.7 U	7.6 U	7.7 U
Acetone	35,000	13	7.9 J	6.8 J	6.7 J	7.1 J	17	9 J	3.9 J	7.6 J	14
Isopropyl Alcohol	NA	1.6 J	1.4 J	0.7 J	0.79 J	0.82 J	1.4 J	1.1 J	1.7 J	2.4 J	1.6 J
Carbon Disulfide	70,000	0.6 J	3.3 U	2.2 J	3.4 U	3.1 U	1.3 J	3.1 U	3.1 U	0.98 J	3.1 U
Methylene Chloride	520	2 J	3.7 U	0.84 J	3.8 U	3.4 U	3.4 U	1 J	1.6 J	3.4 U	3.5 U
Methyl tert-Butyl Ether	300,000	3.6 U	3.8 U	3.6 U	3.9 U	3.6 U	3.6 U	3.6 U	3.6 U	3.6 U	3.6 U
Hexane	20,000	3.6 U	3.8 U	1.5 J	3.8 U	3.5 U	1.6 J	3.6 U	1.3 J	3.5 U	1.8 J
1,1-Dichloroethane	50,000	4.1 U	4.3 U	4 U	4.4 U	4 U	4 U	4.1 U	4.1 U	4 U	4.1 U
2-Butanone	NA	2.5 J	2 J	2 J	1.8 J	1.6 J	3.5	2 J	3 U	1.7 J	2.8 J
Tetrahydrofuran	NA	3 U	2.2 J	2.9 U	3.2 U	2.9 U	2.9 U	2.6 J	3.6	2.9 U	2.1 J
Chloroform	11	4.9 U	5.2 U	4.8 U	5.3 U	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U
1,1,1-Trichloroethane	220,000	5.5 U	5.8 U	5.4 U	5.9 U	5.4 U	5.4 U	5.5 U	5.5 U	5.4 U	5.5 U
Cyclohexane	NA	3.5 U	3.7 U	3.4 U	3.7 U	3.4 U	3.4 U	3.5 U	3.5 U	3.4 U	3.5 U
2,2,4-Trimethylpentane	NA	4.7 U	5 U	4.6 U	5 U	4.6 U	4.6 U	4.7 U	4.7 U	4.6 U	4.7 U
Benzene	31	1.5 J	1.3 J	2.2 J	1.4 J	1.3 J	1.7 J	1.4 J	1.3 J	1.4 J	3 J
1,2-Dichloroethane	9.4	4.1 U	4.3 U	4 U	4.4 U	4 U	4 U	4.1 U	4.1 U	4 U	4.1 U
n-Heptane	NA	4.1 U	4.4 U	4.1 U	4.4 U	4.1 U	4.1 U	4.1 U	4.1 U	4.1 U	4.1 U
1,4-Dioxane	NA	14 U	15 U	14 U	16 U	14 U	14 U	14 U	14 U	14 U	14 U
Toluene	40,000	3.6 J	1.9 J	2.6 J	2.4 J	2.2 J	2.3 J	1.8 J	3.1 J	1.4 J	2.6 J
2-Hexanone	NA	16 U	17 U	16 U	18 U	16 U	16 U	16 U	16 U	16 U	16 U
Ethylbenzene	220	4.4 U	4.6 U	4.3 U	4.7 U	4.3 U	4.3 U	4.4 U	4.4 U	4.3 U	4.4 U
m-Xylene	700,000	4.4 U	4.6 U	4.3 U	4.7 U	4.3 U	4.3 U	4.4 U	4.4 U	4.3 U	4.4 U
o-Xylene	700,000	4.4 U	4.6 U	4.3 U	4.7 U	4.3 U	4.3 U	4.4 U	4.4 U	4.3 U	4.4 U
n-Propylbenzene	14,000	5 U	5.2 U	4.9 U	5.3 U	4.9 U	4.9 U	5 U	5 U	4.9 U	5 U
4-Ethyltoluene	NA	5 U	5.2 U	4.9 U	5.3 U	1.5 J	4.9 U	5 U	5 U	4.9 U	1.7 J
1,3,5-Trimethylbenzene	600	5 U	5.2 U	4.9 U	5.3 U	4.9 U	4.9 U	5 U	5 U	4.9 U	5 U
1,2,4-Trimethylbenzene	600	5 U	5.2 U	4.9 U	5.3 U	1.6 J	4.9 U	5 U	5 U	4.9 U	2.2 J

Notes:

All values are in micrograms per cubic meter (μg/m3)

(1) EPA Draft Document for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils, November 2002 Table 2C, deep soil gas

SGRF-10 and SGRF-11 were not collected due to underground utilities

NA = not available

U = non-detect

J = estimated value

R = rejected

Table 1-8
TO-15 VOC Results - Outdoor Building Soil Gas Samples
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Contaminant	Screening Criteria (1)	SGRF-33	SGRF-33-Dup	SGHP1		SGHP2	SGHP3		SGHP4
		1/6/2006	1/6/2006	1/12/2006	12/22/2005	1/12/2006	1/12/2006	12/22/2005	1/12/2006
Tetrachloroethene	**81**	**6.8 U**	**6.7 U**	**11**	**6.7 U**	**17**	**23**	**6.8 U**	**14**
Trichloroethene	**2.2**	**5.4 U**	**5.3 U**	**5.7 U**	**5.3 U**	**3.9 J**	**12**	**5.4 U**	**3 J**
1,1-Dichloroethene	**20,000**	**4 U**	**3.9 U**	**4.2 U**	**3.9 U**	**3.9 U**	**3.9 U**	**4 U**	**3.9 U**
cis-1,2-Dichloroethene	**3,500**	**4 U**	**3.9 U**	**4.2 U**	**3.9 U**	**2.5 J**	**6.5**	**4 U**	**3.9 U**
Carbon Tetrachloride	**18**	**6.4 U**	**6.2 U**	**6.7 U**	**6.3 U**	**6.3 U**	**6.3 U**	**6.4 U**	**6.3 U**
Dichlorodifluoromethane	20,000	5 U	4.9 U	2.4 J	4.9 U	2.2 J	2.3 J	5 U	2.9 J
Chloromethane	NA	8.3 U	8.1 U	1.9 J	8.2 U	8.2 U	3.3 J	8.3 U	2.4 J
1,3-Butadiene	0.87	2.2 UJ	2.2 UJ	2.4 U	2.2 U	2.2 U	2.2 U	2.2 U	3.9 J
Trichlorofluoromethane	70,000	5.7 U	5.5 U	6 U	5.6 U	5.6 U	1.7 J	5.7 U	5.6 U
Ethanol	NA	3 J	6.7 J	11	7.7	8.5	13	22	10
1,1,2-Trichloro-1,2,2-trifluoroethane	3,000,000	7.7 U	7.5 U	8.2 U	7.6 U	7.6 U	4.3 J	7.7 U	7.6 U
Acetone	35,000	5.5 J	2.7 J	36	22	20	19	20	20
Isopropyl Alcohol	NA	0.81 J	0.82 J	1.9 J	9.8 U	1.5 J	2.8 J	4.7 J	1.4 J
Carbon Disulfide	70,000	3.1 U	1 J	3.3 U	1.4 J	3.1 U	3.1 U	2.1 J	2.9 J
Methylene Chloride	520	3.5 U	3.4 U	3.7 U	1.5 J	3.4 U	1.2 J	4.6	3.4 U
Methyl tert-Butyl Ether	300,000	3.6 U	3.6 U	3.8 U	3.6 U	3.6 U	3.6 U	3.6 U	3.6 U
Hexane	20,000	3.6 U	3.5 U	1.2 J	3.5 U	0.88 J	1.4 J	4.3	1.6 J
1,1-Dichloroethane	50,000	4.1 U	4 U	4.3 U	4 U	4 U	6.8	4.1 U	4 U
2-Butanone	NA	0.91 J	0.96 J	3.7	5.4	2.7 J	2.5 J	3.2	3.6
Tetrahydrofuran	NA	3 U	2.9 U	3.1 U	2.9 U	2.9 U	2.9 U	3 U	2.9 U
Chloroform	11	4.9 U	4.8 U	5.2 U	4.8 U	4.8 U	7.9	4.9 U	4.8 U
1,1,1-Trichloroethane	220,000	5.5 U	5.4 U	5.8 U	5.4 U	5.4 U	21	5.5 U	5.4 U
Cyclohexane	NA	3.5 U	3.4 U	3.7 U	3.4 U	3.4 U	3.4 U	1.7 J	3.4 U
2,2,4-Trimethylpentane	NA	4.7 U	4.6 U	5 UJ	4.6 U	4.6 UJ	4.6 UJ	1.2 J	4.6 UJ
Benzene	31	1.2 J	0.86 J	1.7 J	1.4 J	1.7 J	2 J	3 J	2.6 J
1,2-Dichloroethane	9.4	4.1 U	4 U	4.3 U	4 U	4 U	4 U	4.1 U	4 U
n-Heptane	NA	4.1 U	4 U	4.4 U	4.1 U	4.1 U	4.1 U	4.4	4.1 U
1,4-Dioxane	NA	14 U	14 U	15 U	14 U	14 U	14 U	14 U	14 U
Toluene	40,000	1.4 J	1.3 J	3.2 J	2.5 J	2.8 J	3.2 J	17	3.7 J
2-Hexanone	NA	16 U	16 U	17 U	16 U	16 U	16 U	16 U	16 U
Ethylbenzene	220	4.4 U	4.3 U	4.6 U	4.3 U	4.3 U	4.3 U	2 J	4.3 U
m-Xylene	700,000	4.4 U	4.3 U	4.6 U	4.3 U	4.3 U	4.3 U	5.7	4.3 U
o-Xylene	700,000	4.4 U	4.3 U	4.6 U	4.3 U	4.3 U	4.3 U	2 J	4.3 U
n-Propylbenzene	14,000	5 U	4.8 U	5.2 U	4.9 U	4.9 U	4.9 U	5 U	4.9 U
4-Ethyltoluene	NA	5 U	4.8 U	5.2 U	4.9 U	4.9 U	4.9 U	5 U	4.9 U
1,3,5-Trimethylbenzene	600	5 U	4.8 U	5.2 U	4.9 U	4.9 U	4.9 U	5 U	4.9 U
1,2,4-Trimethylbenzene	600	5 U	4.8 U	5.2 U	4.9 U	4.9 U	4.9 U	1.7 J	4.9 U

Notes:

All values are in micrograms per cubic meter (μg/m3)
(1) EPA Draft Document for Evaluating the Vapor Intrusion to
Indoor Air Pathway from Groundwater and Soils, November 2002
Table 2C, deep soil gas
SGRF-10 and SGRF-11 were not collected due to underground utilities
NA = not available
U = non-detect
J = estimated value
R = rejected

Table 1-9
Fate and Transport Properties for Site-Related VOCs
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CONTAMINANT	Molec. Weight (g/mole)	Water Solubility @25 deg. C (µg/l)	Vapor Pressure @25 deg. C (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Koc (ml/g)	log Kow	Kd (cm^3/g)	Rf	Adsorption	Volatilization from Water	Mobility
TCL VOCs											
Tetrachloroethene	166	1.5E-01	1.8E+01	1.8E-02	3.6E+02	2.6	7.2E-02	1.8E+00	Low	High	High
Trichloroethene	131	1.1E+00	6.9E+01	9.1E-03	1.3E+02	2.4	2.6E-02	1.3E+00	Low	High	High
1,1-Dichloroethene	97	2.3E+00	6.0E+02	2.0E-02	6.5E+01	2.1	1.3E-02	1.1E+00	Low	High	High
1,2-Dichloroethene - cis	97	3.5E+00	2.1E+02	4.1E-03	1.4E+02	1.9	2.8E-02	1.3E+00	Low	High	High
Carbon tetrachloride	154	8.0E-01	9.0E+01	3.0E-02	1.1E+02	2.64	2.2E-02	1.2E+00	Low	High	High

VARIABLES FOR MAGOTHY AQUIFER

Fraction Organic Carbon, fo	0.00020		
Soil Bulk Density, Rho_b =	1.7	(cm^3/g)	(sandy)
Effective Porosity, Eta_e =	15%		
Adsorption is	"Low"	if Kd <	0.5
	"High"	if Kd >	2
	"Moderate"	if Kd is in-between	
Volatilization from Water is	"Low"	if H <	1.0E-07
	"High"	if H >	1.0E-03
	"Moderate"	if H is in-between	
Mobility is	"High"	if Rf <	1.0E+01
	"Low"	if Rf >	1.0E+03
	"Moderate"	if Rf is in-between	

NOTATION

Koc = Soil Organic Carbon/Water Partition Coefficient, cm^3/g

Kow = n-Octanol/Water Partition Coefficient, dimensionless

Kd = Soil/Water Partition Coefficient [= Koc X foc for organics], cm^3/g

Rf = Retardation Factor = 1 + (Rho_b X Kd / Eta_e), dimensionless

Notes:

g/mole = gram per mole
mg/l = milligrams per liter
mm Hg = millimeters of mercury
atm-m3/mol = atmosphere cubic meters per mole
ml/g = milliliters per gram
cm^3/g = cubic centimeters per gram
deg. C = degrees celsius

References:

ATSDR. Tox Profiles. US Department of Health and Human Services (http://atsdr.cdc.gov/toxpro2.html)
Risk Assessment Information System (http://rais.ornl.gov)
EPA Soil Screening Guidance, 1996 (http://epa.gov/superfund/resources/soil/part_5.pdf)

TABLE 1-10
SUMMARY OF CARCINOGENIC RISKS AND NON-CARCINOGENIC HEALTH HAZARDS
REASONABLE MAXIMUM EXPOSURE
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Receptor	Cancer Risk	Notes on Cancer Risk	Noncancer Hazard Index	Notes on Hazard Index (HI)
Future				
Site Worker	2×10^{-4}	Cancer risk is slightly above EPA target range of 1×10^{-4} and 1×10^{-6}. PCE (1×10^{-4}) and TCE (1×10^{-4}) in groundwater contribute 92% of the total risk.	3	Liver - 2.6 from ingestion of TCE in groundwater Kidney - 2.5 from ingestion of TCE in groundwater Fetus - 2.5 from ingestion of TCE in groundwater CNS - 2.5 from ingestion of TCE in groundwater
Resident - Adult	2×10^{-3}	Cancer risk is above EPA target range of 1×10^{-4} and 1×10^{-6}. TCE in groundwater (1.6×10^{-3}) contributes 77% of the total risk.	10	Liver - 9 from ingestion of TCE in groundwater Kidney - 8 from ingestion of TCE in groundwater Fetus - 8 from ingestion of TCE in groundwater CNS - 8 from ingestion of TCE in groundwater
Resident - Child (0 - 6 years old)	6×10^{-3}	Cancer risk is aboveEPA target range of 1×10^{-4} and 1×10^{-6}. TCE in groundwater (5×10^{-3}) contributes 87% of the total risk.	35	Liver - 32 from ingestion of TCE in groundwater Kidney - 29 from ingestion of TCE in groundwater Fetus - 29 from ingestion of TCE in groundwater CNS - 29 from ingestion of TCE in groundwater

Cancer risks: An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. EPA's generally acceptable risk range for site-related exposures is 1×10^{-6} to 1×10^{-4} (one in million to one in ten thousand).

Noncancer hazards: EPA Risk Assessment Guidance for Superfund (EPA 1989) states that, generally, a hazard index (HI) greater than unity (1) indicates the potential for adverse noncancer effects.

TCE = trichloroethene
PCE = tetrachloroethene
CNS = central nervous system

TABLE 1-11
SUMMARY OF CARCINOGENIC RISKS AND NON-CARCINOGENIC HEALTH HAZARDS
CENTRAL TENDENCY EXPOSURE
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

Receptor	Cancer Risk	Notes on Cancer Risk	Noncancer Hazard Index	Notes on Hazard Index (HI)
Future				
Site Worker	6×10^{-5}	Cancer risk is within EPA target range of 1×10^{-4} and 1×10^{-6}.	3	Liver - 2.4 from ingestion of TCE in groundwater Kidney - 2.3 from ingestion of TCE in groundwater Fetus - 2.3 from ingestion of TCE in groundwater CNS - 2.3 from ingestion of TCE in groundwater
Resident - Adult	3×10^{-4}	Cancer risk is slightly above EPA target range of 1×10^{-4} and 1×10^{-6}. TCE in groundwater (2×10^{-4}) contributes 64% of the total risk.	6	Liver - 5 from ingestion of TCE in groundwater Kidney - 5 from ingestion of TCE in groundwater Fetus - 5 from ingestion of TCE in groundwater CNS - 5 from ingestion of TCE in groundwater
Resident - Child (0 - 6 years old)	8×10^{-4}	Cancer risk is above EPA target range of 1×10^{-4} and 1×10^{-6}. TCE in groundwater (7×10^{-4}) contributes to 84% of the total risk.	10	Liver - 9 from ingestion of TCE in groundwater Kidney - 8 from ingestion of TCE in groundwater Fetus - 8 from ingestion of TCE in groundwater CNS - 8 from ingestion of TCE in groundwater

Cancer risks: An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. EPA's generally acceptable risk range for site-related exposures is 1×10^{-6} to 1×10^{-4} (one in million to one in ten thousand).
Noncancer hazards: EPA Risk Assessment Guidance for Superfund (EPA 1989) states that, generally, a hazard index (HI) greater than unity (1) indicates the potential for adverse noncancer effects.

TCE = trichloroethene
PCE = tetrachloroethene
CNS = central nervous system

Table 2-1
Chemical-specific ARARs, Criteria, and Guidance
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

Regulatory Level	ARAR Identification	Status	Requirement Synopsis	Feasibility Study Consideration
Federal	National Primary Drinking Water Standards-Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs)	Relevant and Appropriate	Establishes health-based standards for public drinking water systems. Also establishes drinking water quality goals set at levels at which no adverse health effects are anticipated, with an adequate margin of safety.	The MCLs and MCLGs will be considered in the development of the PRGs if there are no applicable standards.
Federal	OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils	To be considered	Establishes the approach to evaluate vapour intrusion and provides generic levels of vapor contaminant concentrations that may pose human health risk	Considered
State	New York Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (6NYCRR Part 703)	Applicable	Establish numerical standards for groundwater and surface water cleanups.	The standards will be used to develop the PRGs.
State	New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (Technical and Operational Guidance Series 1.1.1)	Relevant and Appropriate, To Be Considered (guidance value)	Provides ambient water quality guidance values and groundwater effluent limitations for use where there are no standards.	The guidance values will be considered in the development of the PRGs if there are no applicable standards.
State	New York State Department of Health Drinking Water Standards (10NYCRR Part 5)	Relevant and Appropriate	Sets maximum contaminant levels (MCLs) for public drinking water supplies.	The standards will be considered in the development of the PRGs if there are no applicable standards.

Table 2-2
Location-specific ARARs, Criteria, and Guidance
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

Regulatory Level	ARARs	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
General	National Historic Preservation Act (40 CFR 6.301)	To Be Considered	This requirement establishes procedures to provide for preservation of historical and archeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	The effects on historical and archeological data will be evaluated during the identification, screening, and evaluation of alternatives.

Table 2-3
Action-specific ARARs for Site Remediation
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

ARARs	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
General Requirement for Site Remediation			
OSHA—Record keeping, Reporting, and Related Regulations (29 CFR 1904)	Applicable	This regulation outlines the record keeping and reporting requirements for an employer under OSHA.	These regulations apply to the companies contracted to implement the remedy. All applicable requirements will be met.
OSHA—General Industry Standards (29 CFR 1910)	Applicable	These regulations specify an 8-hour time-weighted average concentration for worker exposure to various organic compounds. Training requirements for workers at hazardous waste operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is not possible to maintain the work atmosphere below the 8-hour time-weighted average at these specified concentrations.
OSHA—Construction Industry Standards (29 CFR 1926)	Applicable	This regulation specifies the type of safety equipment and procedures to be followed during site remediation.	All appropriate safety equipment will be on site, and appropriate procedures will be followed during remediation activities.
RCRA Identification and Listing of Hazardous Wastes (40 CFR 261)	Applicable	Describes methods for identifying hazardous wastes and lists known hazardous wastes.	Applicable to the identification of hazardous wastes that are generated, treated, stored, or disposed during remedial activities.
RCRA Standards Applicable to Generators of Hazardous Wastes (40 CFR 262)	Applicable	Describes standards applicable to generators of hazardous wastes.	Standards will be followed if any hazardous wastes are generated onsite.
RCRA—Standards for Owners/Operators of Permitted Hazardous Waste Facilities (40 CFR 264.10–164.18)	Relevant and Appropriate	This regulation lists general facility requirements including general waste analysis, security measures, inspections, and training requirements.	Facility will be designed, constructed, and operated in accordance with this requirement. All workers will be properly trained.
RCRA—Preparedness and Prevention (40 CFR 264.30–264.31)	Relevant and Appropriate	This regulation outlines the requirements for safety equipment and spill control.	Safety and communication equipment will be installed at the site. Local authorities will be familiarized with the site.

Table 2-3
Action-specific ARARs for Site Remediation
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

ARARs	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
RCRA—Contingency Plan and Emergency Procedures (40 CFR 264.50–264.56)	Relevant and Appropriate	This regulation outlines the requirements for emergency procedures to be used following explosions, fires, etc.	Emergency Procedure Plans will be developed and implemented during remedial design. Copies of the plans will be kept on site.
New York Hazardous Waste Management System – General (6 NYCRR Part 370)	Applicable	This regulation provides definition of terms and general standards applicable to hazardous wastes management system.	The regulations will be applied to any hazardous waste operation during remediation of the site.
New York Identification and Listing of Hazardous Waste (6 NYCRR Part 371	Applicable	Describes methods for identifying hazardous wastes and lists known hazardous wastes.	Applicable to the identification of hazardous wastes that are generated, treated, stored, or disposed during remedial activities.
Waste Transportation			
Department of Transportation (DOT) Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171, 172, 177 to 179)	Applicable	This regulation outlines procedures for the packaging, labeling, manifesting, and transporting hazardous materials.	Any company contracted to transport hazardous material from the site will be required to comply with this regulation.
RCRA Standards Applicable to Transporters of Hazardous Waste (40 CFR 263)	Applicable	Establishes standards for hazardous waste transporters.	Any company contracted to transport hazardous material from the site will be required to comply with this regulation.
New York Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities (6 NYCRR Part 372)	Applicable	Establishes record keeping requirements and standards related to the manifest system for hazardous wastes.	Any company contracted to transport hazardous material from the site will be required to comply with this regulation.
New York Waste Transporter Permit Program (6 NYCRR Part 364)	Applicable	Establishes permit requirements for transportations of regulated waste.	Must use permitted waste transporters when shipping wastes.
Waste Disposal			
RCRA Land Disposal Restrictions (40 CFR 268)	Relevant and Appropriate	This regulation identifies hazardous wastes restricted for land disposal and provides treatment standards for land disposal.	Hazardous wastes will be treated to meet disposal requirements.

Table 2-3
Action-specific ARARs for Site Remediation
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

ARARs	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
New York Standards for Universal Waste (6 NYCRR Part 374-3) and Land Disposal Restrictions (6 NYCRR Part 376)	Applicable	These regulations establish standards for treatment and disposal of hazardous wastes.	Hazardous wastes must comply with the treatment and disposal standards.
Groundwater Discharge			
Clean Water Act (CWA [40 CFR 122, 125)	Relevant and Appropriate	National Pollutant Discharge Elimination System (NPDES) permit requirements for point source discharges must be met, including the NPDES Best Management Practice Program. These regulations include, but are not limited to, requirements for compliance with water quality standards, a discharge monitoring system, and records maintenance.	Project will meet NYPDES permit requirements for point source discharges.
Clean Water Act (Federal Ambient Water Quality Criteria [FAWQC] and Guidance Values [40 CFR 131.36])	To Be Considered	Establishes criteria for surface water quality based on toxicity to aquatic organisms and human health.	The criteria will be evaluated for surface water discharge of treated groundwater
Safe Drinking Water Act – Underground Injection Control Program (40 CFR 144, 146)	Relevant and Appropriate	Establish performance standards, well requirements, and permitting requirements for groundwater re-injection wells	Project will evaluate the requirement for treated groundwater reinjection and injection of reagent for in situ treatment
New York Regulations on State Pollution Discharge Elimination System (SPDES) (6 NYCRR parts 750-757)	Applicable	This permit governs the discharge of any wastes into or adjacent to State waters that may alter the physical, chemical, or biological properties of State waters, except as authorized pursuant to a NPDES or State permit.	Project will meet NPDES permit requirements for surface discharges of any wastes. Monitoring of discharges will be conducted as required.
New York Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (6NYCRR Part 703)	Applicable	Establish numerical criteria for groundwater treatment before discharge.	Project will meet groundwater effluent limitations before discharge.

Table 2-3
Action-specific ARARs for Site Remediation
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

ARARs	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (TOGS 1.1.1)	Relevant and Appropriate, To Be Considered (for guidance value)	Provides groundwater effluent limitations for use where there are no standards.	The guidance values will be considered for the treated groundwater to be discharge into surface water body.
Off-Gas Management			
Clean Air Act (CAA)—National Ambient Air Quality Standards (NAAQs) (40 CFR 50)	Applicable	These provide air quality standards for particulate matter, lead, NO_2, SO_2, CO, and volatile organic matter.	During excavation, treatment, and/or stabilization, air emissions will be properly controlled and monitored to comply with these standards.
Federal Directive – Control of Air Emissions from Superfund Air Strippers (OSWER Directive 9355.0-28)	To Be Considered	These provide guidance on the use of controls for superfund site air strippers as well as other vapor extraction techniques in attainment and non-attainment areas for ozone.	Project will consider the requirements in remediation alternatives that involve air stripping and vapor extraction process.
New York General Provision (6 NYCRR Part 200)	Applicable	Set the general requirements for air pollution prevention	Prevent any air contamination source to emit air contaminants in quantities would contravene any applicable ambient air quality standard and/or cause air pollution and equipment for air pollution reduction shall be properly operated and maintained
New York Permits and Certificates (6 NYCRR Part 201)	Applicable	Permits may be exempted for listed trivial activities	Air-stripper emission from groundwater remediation activity is considered trivial activity and does not require application for an air permit

Table 2-3
Action-specific ARARs for Site Remediation
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

ARARs	Status	Requirement Synopsis	Action to be Taken to Attain ARARs
New York Emissions Verification (6 NYCRR Part 202)	Applicable	Specify the sampling and documentation requirements for emission monitoring.	Air samples will be collected at required frequency and using approved methods for emission from air stripper or right before into the atmosphere
New York General Prohibitions (6 NYCRR Part 211)	Applicable	Prohibition applies to any particulate, fume, gas, mist, odor, smoke, vapor, pollen, toxic or deleterious emissions.	Proper dust suppression methods and monitoring will be required when implementing excavation, decontamination, and/or stabilization actions to prevent particulate matter from becoming airborne.
New York General Process Emission Sources (6 NYCRR Part 212)	Applicable	Set the treatment requirements for certain emission rates	Based on the emission rate of the air stripper system, the removal efficiency for off-gas unit will meet the requirements set in this regulation.
New York Air Quality Standards (6 NYCRR Part 257)	Applicable	This regulation requires that maximum 24-hour concentrations for particulate matter not be exceeded more than once per year. Fugitive dust emissions from site excavation activities must be maintained below 250 micrograms per cubic meter ($\mu g/m^3$).	Proper dust suppression methods, such as water spray, will be specified when implementing excavation and/or solidification/stabilization actions.
Well Drilling Permit Requirements			
New York State Department of Environmental Conservation (6 NYCRR Part 602) Applications for Long Island Wells	Applicable	Require permit approval for drilling water wells in County of Kings, Queens, Nassau or Suffolk when the total capacity of such well or wells in excess of 45 gallons per minute.	Will establish groundwater use restrictions utilizing this requirement.
New York State Department of Health State Sanitary Code Appendix 5-B Standards for water wells	Relevant	Require that water wells will not be drilled at contaminated area	This can be part of institutional control that prevent drilling of private water wells in the contaminated area

Table 2-4
Preliminary Remediation Goals for Groundwater
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

Contaminants of Concern	National Primary Drinking Water Standards[1] (µg/L)	NYS Groundwater Quality Standards[2] (µg/L)	NYSDOH Drinking Water Quality Standards[3] (µg/L)	PRGs[4] (µg/L)	Maximum Detected Concentrations (µg/L)
Volatile Organic Compounds					
Trichloroethene (TCE)	5	5	5	5	**280**
Tetrachloroethene (PCE)	5	5	5	5	**350**
cis-1,2-dichloroethene (cis-1,2-DCE)	70	5	5	5	**26 J**
1,1-dichloroethene	7	5	5	5	**22**

Notes:
1. EPA National Primary Drinking Water Standards (web page), EPA 816-F-03-016, June 2003
2. New York Surface Water and Ground Water Quality Standards (6NYCRR Part 703), August 4, 1999
3. New York State Department of Health Drinking Water Standards (10NYCRR Part 5)
4. The PRGs are selected based on NYS Groundwater Quality Standards and drinking water standards

Bold figures indicate detected concentrations exceed PRGs.
NYSDOH = New York State Department of Health.
PRG = Preliminary Remedial Goal.
µg/L = micrograms per liter.

Table 2-5
Technology Evaluation for Groundwater
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

General Response Action	Remedial Technology	Process Options	Description	Effectiveness	Implementability	Cost	Retained
No Action	None	Not Applicable	The No Action alternative is retained as a baseline for comparison with other alternatives as required by National Contingency Plan (NCP). No remedial actions will be implemented. Garden City supply wells GWP-10 and GWP-11 would continue to pump at rates comparable to the past five years. The groundwater is currently treated with air strippers and a disinfection unit before discharge to Garden City's water system. Under No Action,the supply wells would continue to operate according to the city's water demand. Although it is unlikely, these two wells may be shut down over extended periods of time if the village deems it necessary. If this were to occur, the groundwater contamination would migrate downgradient.	The results of the Remedial Investigation (RI) indicate that the existing two Garden City supply wells GWP-10 and GWP-11 have limited the plume from migrating downgradient. Under this alternative, there are no requirement to prevent contaminated groundwater from posing human health risk. The No Action Response does not prevent human exposure to contaminated groundwater and it does not meet the RAOs.	Implementable. No significant administrative difficulties are anticipated, and no action would be taken.	No capital, operation, or maintenance costs.	Yes
Institutional Controls	Deed Restrictions and Well Drilling Restrictions	Not Applicable	Deed restrictions and well drilling restrictions within the contaminant plume would eliminate the exposure pathways to contaminated groundwater through restricted uses of groundwater and the property within contamination affected areas.	Deed restrictions and well drilling restrictions can effectively eliminate the potential exposure pathways to contaminated groundwater through restricted uses of the affected areas. However, this will not reduce the migration and the associated environmental impact.	Deed restrictions and well drilling restrictions would be implemented through the current administrative system. Deed restrictions need to be developed among different governmental agencies to limit the current and future land use options as long as the contamination exists at an unacceptable level, and may be difficult to enforce over the long term. Deed restrictions and well drilling restrictions may also be used in addition to remediation activities, as a protective measure to prevent exposure to contaminants during remediation.	Low costs for administration.	Yes
	Long-term Monitoring	Not Applicable	Long-term monitoring includes periodic sampling and analysis of groundwater samples providing an indication of the movement of the contaminants and/or of the progress of remedial activities. Currently, the extracted groundwater at the two supply wells is regularly tested.	Long-term monitoring would not alter the effects of the contamination on human health. Monitoring is only reliable for tracking the migration and levels of contaminants.	Implementable through sampling of the existing monitoring well network. It is a proven and reliable process, and could be easily implemented. All monitoring wells are easily accessible for sample collection.	Low capital costs to establish the sampling work plan and procedures. Medium operation and maintenance costs.	Yes
Monitored Natural Attenuation (MNA)	MNA	Not Applicable	MNA uses natural subsurface processes (e.g., dilution, volatilization, biodegradation, adsorption, and reaction with subsurface materials) to reduce contaminant concentrations to acceptable levels. At sites with contaminant concentrations significantly higher than cleanup criteria, it usually requires evidence of effective biological degradation to ensure that MNA is a sufficient remedy. Concentrations of contaminants, degradation byproducts and indicator parameters (e.g., oxidation/reduction potential) are monitored to verify the effectiveness of natural attenuation.	At this site, dissolved oxygen (DO) and oxidation reduction potential (ORP) measurements during well purging and development indicate anoxic conditions at well SVP-4. But the concentration of cis-1,2-DCE is very low and vinyl chloride has not been detected. There might be very limited level of naturally occurring biodegradation of PCE and TCE through reductive dechlorination in the past. There are not sufficient evidences to indicate on-going anaerobic degradation of PCE and TCE. In addition, the highest PCE and TCE concentrations have reached the public supply wells. Therefore, MNA is not effective at this site.	Implementable. Requires periodic groundwater sampling and analysis to monitor the contaminant distribution and movements. However, it will not be implemented at the site because there is not sufficient evidence of its effectiveness	Low capital costs. Medium operation and maintenance costs. Would also include long-term monitoring.	No
Containment	Vertical Barrier	Slurry Walls	A slurry wall is a subsurface barrier consisting of a vertically excavated trench filled with a slurry. The slurry (typically either a soil/bentonite mixture or a cement/bentonite mixture) prevents the trench from collapsing and provides a physical barrier to groundwater flow.	Effective to achieve hydraulic control for shallow contaminant plume. The walls could deteriorate over time due to the presence of chlorinated VOCs. Upon the completion of remedial activities, the walls would remain in place and continue to influence groundwater flow patterns on a localized scale.	Not implementable. Typical slurry wall applications reach installation depths of about 30 to 40 feet bgs, based upon practical limitations associated with excavator trenching. Slurry walls can be installed to depths exceeding 100 feet bgs using a clam shovel at a higher unit cost. At the site, the contamination has been found to exist more than 400 feet bgs, exceeding the practical limits of the slurry wall.	High capital costs.	No
		Sheet Pile Barriers	Sheet pile barriers (e.g., walls) are constructed by driving or vibrating sections of steel sheet piling into the ground. Each sheet pile section is interlocked at its edges, and the seams are often grouted to prevent leakage.	Effective at providing hydraulic control. Sheet pile barriers may deteriorate over time under acidic or alkaline conditions, or in the presence of chlorinated VOCs, such as PCE, that exist at this site.	Not implementable. Typical sheet pile wall applications reach installation depths of about 80 feet bgs, based upon practical limitations associated with installation. Sheet pile walls can be installed to depths exceeding 100 feet bgs at a higher unit cost. At the site, the contamination has been found to exist more than 400 feet bgs, exceeding the practical limits of sheet piling.	High capital costs.	No
Extraction	Groundwater Extraction	Extraction Wells	Groundwater extraction wells can be installed to prevent the downgradient migration of a contaminant plume.	Effective in providing hydraulic control, at sites where the hydrogeology is well understood and the pumping rate necessary to maintain hydraulic control is sustainable. Continuous pumping would be sustainable at this site.	Implementable. Groundwater modeling is used to simulate the effective capture of the contaminant plume.	Medium capital costs, medium operation and maintenance cost	Yes
		Extraction Trenches	Extraction trenches are constructed perpendicular to the direction of groundwater flow to intercept and prevent downgradient migration of a shallow contaminant plume. The trench is typically backfilled with material of higher permeability than the native aquifer (e.g., gravel) to create a zone of preferential flow, and perforated piping or extraction wells are typically installed in the trench to collect the intercepted groundwater.	Effective in capturing shallow groundwater to provide hydraulic control. Extraction trenches are not typically installed at depths greater than 30 feet bgs due to equipment limitations and, therefore, would not be effective for this site.	Not implementable due to the depth of contaminated groundwater.	Medium capital costs.	No

Table 2-5
Technology Evaluation for Groundwater
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

General Response Action	Remedial Technology	Process Options	Description	Effectiveness	Implementability	Cost	Retained
Treatment	Ex Situ Treatment	Precipitation and Filtration	Physically removes dissolved and suspended solids from groundwater in order to reduce fouling within the subsequent treatment processes.	Proven technology, effective in removing solid materials, needs to be combined with other treatments to remove VOC contaminants.	Easily implementable.	Medium capital. Medium operation and maintenance cost.	Yes
		Air Stripping	Air stripping involves the mass transfer of volatile contaminants from water to air by increasing the surface area of the groundwater exposed to air. The commonly used systems are countercurrent packed column, multiple chamber fine bubble aeration system, and low profile sieve tray air strippers.	Air stripping is effective in removing VOCs from groundwater. Off gas may require treatment prior to discharge.	Implementable. May require permit for discharge of VOCs to the atmosphere and/or off-gas treatment (i.e., vapor phase carbon) prior to discharge.	Medium capital cost. medium operation and maintenance cost.	Yes
		Liquid-Phase Activated Carbon Adsorption	Contaminants in groundwater are adsorbed by passing the extracted groundwater through a series of reactor vessels containing granular activated carbon. Spent carbon must be reactivated or replaced periodically.	Carbon adsorption is not effective in removing VC, a degradation byproduct of PCE and TCE. However, no VC has been detected at this site.	Implementable. Technology can treat groundwater. No administrative difficulties anticipated for implementation of a carbon adsorption system.	Medium capital costs. Medium operation and maintenance costs.	Yes
		Vapor-Phase Activated Carbon Adsorption	Carbon adsorption can be used to treat the off-gas generated during air stripping. Activated carbon is not effective in the removal of vinyl chloride (VC); an additional treatment method would be required for sites with significant concentrations of VC. However, VC has not been detected at this site.	Effective in removing contaminants with moderate or highly organic carbon partition coefficients (K_{oc}) from off-gas. Not effective for VC; however, VC has not been detected at this site.	This technology is implementable and proven.	Medium capital cost. Medium operation and maintenance costs.	Yes
		Ultraviolet (UV) Oxidation	Contaminated groundwater is transferred to a reactor where it is combined with ozone and/or hydrogen peroxide and irradiated with UV light. Organic contaminants are destroyed as a result of the synergistic action of the oxidant with the UV light. Systems may require off-gas treatment to destroy unreacted ozone and volatilized contaminants.	UV oxidation is effective in the destruction of a wide variety of organic contaminants including chlorinated hydrocarbons (e.g., TCE, PCE, and VC). Aqueous stream must have good transmissivity; high turbidity causes interference.	Implementable. Minor administrative difficulties anticipated for implementation of a UV oxidation system; may require permit for discharge of unreacted ozone and volatilized VOC. Alternatively, treatment of off-gas may be required.	High capital costs. High operation and maintenance costs.	No
		Biological Treatment	Ex situ biological treatment techniques stimulate microorganisms to grow and use contaminants as a food and energy source by creating a favorable environment for the microorganisms. Oxygen content, redox potential, nutrient balance, temperature, and pH are factors which need to be controlled in order to ensure proper treatment.	Enhanced anaerobic degradation has been demonstrated to be effective in degrading chlorinated solvents. Biodegradation may require longer residence time than other treatment technologies to treat the same quantity of contaminants; a larger treatment facility could be used.	Implementable. However, the groundwater is under aerobic conditions. It would require changing the extracted groundwater from aerobic conditions to anaerobic conditions for degradation to occur.	Medium capital cost. Medium maintenance costs.	No
	In Situ Treatment	Phytoremediation	Phytoremediation uses plants and their associated rhizospheric microorganisms to remove and/or degrade contaminants in groundwater. Contaminants are removed through: capture of groundwater; uptake of contaminants and accumulation or processing of contaminants via metabolization, mineralization, and transpiration; and rhizospheric degradation via microorganisms.	Phytoremediation is applicable for relatively shallow groundwater (less than 10 feet bgs) and large groundwater plumes with low levels of contamination, since high levels of contaminants may be toxic to the plants.	Not implementable for the site because contamination is found at depths significantly greater than 10 feet bgs.	Low capital costs. Low operation and maintenance costs.	No
		Permeable Reactive Barriers (PRBs)	PRBs are constructed perpendicular to the flow path of a contaminant plume. Contaminants are removed through reaction with the permeable reactive medium. Barriers may be permanent or replaceable units and are typically constructed using conventional trenching techniques for shallow groundwater contamination. PRBs can also be placed at greater depth using hydraulic fracturing and injection methods.	PRBs constructed of zero-valent iron filings are effective in the treatment of TCE/PCE to below detection limits. PRBs would be effective for heterogeneous soil conditions. PRBs may lose efficiency over some years due to precipitation caused by unfavorable groundwater geochemistry. Reactivation of PRBs or reinstallation of PRBs may be necessary after 15 years.	Conventional trenching method is not applicable at this site due to the significant depth of contaminated groundwater. Trenchless method using hydraulic fracturing and injection had successfully placed PRBs to 115 feet bgs. Implementing a PRB at more than 400 feet bgs is not a proven technology.	High capital costs compared to other in situ treatment technologies. Low operation and maintenance costs for groundwater monitoring; these costs may be significant if replacement of reactive medium is necessary.	No
		In Situ Chemical Oxidation (ISCO)	ISCO involves the injection of chemical oxidants into the subsurface to destroy organic contaminants in groundwater. Complete oxidation of contaminants results in their breakdown into non-toxic compounds, such as carbon dioxide, water, and minerals. Repeat application of oxidant is generally required due to mass transfer from areas of low permeability into areas of higher permeability.	ISCO is an effective treatment for reduction of chlorinated solvents at the source area. The effectiveness of ISCO depends on adequate contact between oxidants and contaminants. Subsurface heterogeneities can affect delivery of the oxidant. In addition, sufficient amount of oxidants is needed to overcome the soil oxidant demand. Especially for permanganate, since even sandy soil generally has very high permanganate demand. At this site, no residual soil source is found. The contaminant plume is huge and at relative low concentrations. Using ISCO to treat a dissolve plume will be cost prohibitive since most of the oxidant will be consumed by the soil.	Implementing ISCO at this site would be highly challenging due to the huge lateral size of the plume and more than 300 feet thickness of the plume. It is impossible to apply the oxidant over the entire plume. The treatment wall technology may be implementable and permanganate may be easier to implement than other oxidants, due to its relative long life (a few months) demonstrated in subsurface formation similar to this site. However, to treat the huge plume using a treatment wall means frequent reapplication of the oxidant. A bench scale test for soil oxidant demand could prove very helpful to determine oxidant loading.	High capital cost. High operation and maintenance cost.	No

Table 2-5
Technology Evaluation for Groundwater
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

General Response Action	Remedial Technology	Process Options	Description	Effectiveness	Implementability	Cost	Retained
Treatment (continued)	In Situ Treatment (continued)	Groundwater Circulation Wells (GCW)	GCW systems focus on creating in situ vertical groundwater circulation cells by drawing groundwater from an aquifer formation through one screen and discharging it through the second screen of a double-screened well. This circulation commonly occurs from the top of the formation to the bottom. Contaminated groundwater flowing upward inside the well and be treated through air stripping or carbon adsorption.	GCW systems effectively treat CVOCs if vertical circulation can be established. It has failed at many sites due to (1) short circulting around the well or (2) vertical hydraulic conductivity is much greater than horizontal hydraulic conductivity, such that the system can not form a circulation loop to effectively treat the contamination in the designed treatment zone. At this site, the Magothy aquifer consists of alternating sequences and gradations of sand, clayey sand, sandy clay, clay, lignite, and some gravel. The vertical hydraulic conductivity is 30 to 60 times higher than the horizontal hydraulic conductivity. The effectiveness of GCW may be minimal due to the heterogeneous geology.	Difficult to implement due to the significant depth and thickness of contaminant plume. System also requires intensive maintenance.	High capital cost. high operation and maintenance cost.	No
		Air Sparging (AS) with Soil Vapor Extraction (SVE)	Clean air is injected into groundwater to strip the chlorinated contaminants via volatilization. The contaminant-containing air is then removed from the vadose zone using an SVE system.	The effectiveness of AS with SVE is questionable at this site due to the depth of contamination and the possibilities of recontaminating the overlaying layer of groundwater and vapor intrusion into nearby buildings. The effectiveness of AS/SVE depends on how well the injected air permeates the groundwater from the injection point. Low permeable clay seams may prevent air penetration locally and spread contaminants laterally. At this site, the Magothy formation where the contaminant plume exists is highly heterogeneous with clay seams. The deepest contaminants are more than 400 feet bgs. Using air sparging will cause siginificant horizontal and vertical redistribution of contaminants. Complete capturing of the VOCs in the vadose zone will be extremely difficult when the contaminants can migrate more than 400 feet away laterally from the injection points. The increased risks from vapor intrustion minimize the effectiveness of AS/SVE at the site.	Extremely difficult to Implement due to the depth of contamination. It would be very expensive to install a AS/SVE well network within the plume area due to the size and the depth of contamination.	High capital cost. Medium operation and maintenance costs.	No
		Enhanced Anaerobic Bioremediation (EAB)	EAB is a groundwater remedial technology designed to facilitate the in situ biological destruction of chlorinated VOCs over a wide range of concentrations in groundwater. EAB involves the injection of an electron donor, nutrients, and potentially dechlorinating microorganisms into the subsurface to stimulate the natural reactions of microorganisms to detoxify chlorinated solvent contamination in a low organic environment.	The addition of an electron donor as an energy source for indigenous microorganisms would stimulate the development of reduced groundwater environments that are conducive to dechlorination reactions (i.e., methanogenic conditions), and fuel the dechlorination process itself. Once generated, the reductive dechlorination environments would stay for sometime and any contaminants diffused out of low permeable zones would be dechlorinated. To sustain the effective treatment of contaminated groundwater, the electron donor need to be added into the subsurface continuously or repeatedly. EAB may stall at cis-DCE. Bioaugmentation is likely needed at this site to completely degrade PCE/TCE to ethene.	Implementing EAB will be very difficult because distributing electron donor over the entire contaminant plume is not practical. Passive bio-barrier technology using slow release amendment can be implemented upgradient of the two supply wells to intercept the plume. The current available slow release amendment such as emulsified oil has more than 2 years longevity. Repeated amendment injection will be required. Injection wells need to be used. Even distribution of the amendment over the entire plume within the biobarrier will also be a challenge. The bio-barrier would need to be placed upgradient far enough from the two supply wells, so as not to impact the water quality.	Extremely high capital cost even with one bio-barrier. High operation and maintenance costs due to repeated operation of amendment injection.	No
Discharge	On-site Discharge	On-site Injection	Treated groundwater is discharged on site to the subsurface through a series of injection wells.	Groundwater must be treated to meet discharge requirements. At the site, sand and gravel would effectively accept reinjected treated groundwater.	Implementable. Minor administrative difficulties anticipated for groundwater reinjection; discharge permit may be required for injection to the subsurface.	Medium capital costs. High operation and maintenance costs.	Yes
		On-site Surface Recharge	Treated groundwater can be disposed on-site using a surface recharge system such as a drain field or a recharge basin. Recharge basins are shallow ponds that allow water to infiltrate into the ground gradually, and depending on the permeability of the soil, generally require large surface areas.	Effectiveness of this option would rely on the proper construction of the recharge system, including adequate sizing, and use of suitable sand and gravel. Currently, there are two recharge basins at the south end of the site that can be utilized.	Implementable, as standard construction methods and materials would be utilized.	Low capital costs. Low operation and maintenance costs.	Yes
	Off-site Discharge	Surface Water Discharge	Treated groundwater is discharged to an off-site surface water body such as a nearby stream.	Discharge to an off-site surface water body would be an effective method for disposal of treated groundwater, depending on the distance from the treatment system to the stream.	Not implementable. There is no surface water body nearby the site.	Low capital costs. Low operation and maintenance costs.	No

NOTES:

[box]	: Technology eliminated from further evaluation.
bgs	: Below Ground Surface
DO	: Dissolved oxygen
RAO	: Remedial Action Objective
ORP	: Oxidation-Reduction potential
VOC	: Volatile Organic Compound
CVOC	: Chlorinated Volatile Organic Compound
PCE	: Tetrachloroethene
TCE	: Trichloroethene
DCE	: Dichloroethene
VC	: Vinyl chloride

Table 4-1
Groundwater Inorganic Analytical Results - Iron and Manganese
Old Roosevelt Field Contaminated Grounwater Site
Garden City, New York

		Chemical Name	**Iron**	**Manganese**
		Unit	µg/L	µg/L
Sample ID	**Sample Date**	NYSDEC GW STD	300	300
GWM-01-3-R2	7/14/2006	370 to 375 ft	**391**	180
GWM-02-6-R2	7/14/2006	250 to 255 ft	45.9 J	82.1
GWM-03-3-R2	7/17/2006	370 to 375 ft	178	46.9
GWM-04-7-R2	7/17/2006	185 to 190 ft	178	**462**
GWM-05-6-R2	7/18/2006	250 to 255 ft	140	61.1
GWP-10-R2	7/10/2006	377 to 417	100 U	15 U
GWP-11-R2	7/10/2006	370 to 410	91.5 J	15 U
GWP-11-R2-DUP	7/10/2006	370 to 410	100 U	15 U
GWX-10019-R2	7/11/2006	223 to 228 ft	**5140**	265
GWX-10020-R2	7/10/2006	185 to 190 ft	**1630**	181
GWX-8068-R2	7/10/2006	265 to 291 ft	59.3 J	15 U
GWX-8474-R2	7/10/2006	485 to 566 ft	100 U	15 U
GWX-8475-R2	7/10/2006	409 to 556 ft	100 U	15 U

NOTES:
J - The identification of the analyte is acceptable; the reported calue is an estimate.
U - The analyte was not detected at or above the reporting limit.
NYSDEC - New York State Department of Environmental Conservation.
GW - groundwater
STD - standard
Bold indicates the detected sample value exceeded NYSDEC groundwater standards.
Only results from wells within the Old Roosevelt Field and screened in Magothy aquifer are presented.

Table 5-1
Summary of Comparative Analysis of Groundwater Remedial Action Alternatives
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

EVALUATION CRITERION	ALTERNATIVE 1 No Action	ALTERNATIVE 2 Monitoring	ALTERNATIVE 3 Pump and Treat
Summary of Components	None	■ Long-term groundwater monitoring ■ Institutional controls ■ Soil vapor sampling ■ Five-year reviews	■ Evaluation and upgrade of existing air strippers as necessary at GWP-10 and GWP-11 ■ Pre-design investigation ■ Groundwater modeling ■ Stage II Cultural Resource Survey (as necessary) ■ Groundwater extraction well(s) ■ Ex-situ treatment system ■ Discharge of treated water ■ Institutional controls ■ Long-term groundwater monitoring ■ Soil vapor sampling ■ Five-year reviews
Overall Protection of Human Health and the Environment	Would not provide overall protection of human health and the environment. No action would be implemented to prevent human exposure to contaminated groundwater.	Would not be protective of human health and the environment with monitoring of the groundwater plume and vapor sampling. Would provide minimal protection of human health through institutional control. The contaminant plume would be monitored and vapor intrusion investigation would be conducted as necessary.	Protective of human health and the environment through implementation of a remedial pump and treat system to extract and treat contaminated groundwater. The vapor intrusion investigation would be conducted as necessary.

Table 5-1
Summary of Comparative Analysis of Groundwater Remedial Action Alternatives
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

EVALUATION CRITERION	ALTERNATIVE 1 No Action	ALTERNATIVE 2 Monitoring	ALTERNATIVE 3 Pump and Treat
Compliance with ARARs	Would not achieve chemical-specific ARARs due to limited natural attenuation processes (dispersion and dilution) at the site. Location and action-specific ARARs do not apply.	Would not achieve chemical-specific ARARs (including the MCLs). Action-specific ARARs would be met through compliance with health and safety requirements during groundwater sampling.	Would achieve chemical-specific ARARs (including the MCLs) through extraction and treatment of contaminated groundwater. Location and action-specific ARARs would be met through compliance with health and safety and off-gas treatment requirements and water discharge criteria.
Long-term Effectiveness and Permanence	Would not achieve long-term effectiveness and permanence. The potential of human exposure to site contaminants would not be eliminated.	Would not achieve long-term effectiveness and permanence since the alternative only includes monitoring of the groundwater.	This alternative would be considered a permanent remedy and effective in the long-term. It would reduce the contaminant concentrations in groundwater within the treatment areas to below the MCLs. Technologies under this alternative would be considered adequate and reliable in reducing and controlling the site contamination. Institutional controls would be effective in eliminating the human exposure pathways.
Reduction of Toxicity/ Mobility/Volume (T/M/V) Through Treatment	Would not reduce T/M/V because no treatment would be utilized. Natural attenuation through biodegradation is minimal since the groundwater is aerobic. Dilution and dispersion would result in limited reduction of contaminants.	Would not reduce T/M/V because no treatment would be utilized. Natural attenuation through biodegradation is minimal since the groundwater is aerobic. Dilution and dispersion would result in limited reduction of contaminants.	The T/V of the contaminants would be reduced through groundwater extraction and air stripping. M would be limited through hydraulic control of the contaminant plume.

Table 5-1
Summary of Comparative Analysis of Groundwater Remedial Action Alternatives
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

EVALUATION CRITERION	ALTERNATIVE 1 No Action	ALTERNATIVE 2 Monitoring	ALTERNATIVE 3 Pump and Treat
Short-term Effectiveness	There would be no short-term impact to workers or the community, as there would be no remedial activity under this alternative.	Groundwater sampling activities would have very limited short-term impacts to the communities during annual sampling. Use of PPE by workers during groundwater sampling would prevent exposure to contaminated groundwater.	Installation of monitoring wells, one extraction well, and construction of a treatment facility and its associated piping would have limited disturbance to the local community. Implementation of health and safety plan and use of PPE by workers during pre-design investigations, groundwater sampling, and construction would protect workers from exposure to contaminated groundwater.
Implementability	Would be easy to implement.	Would be easy to implement.	Would be easy to implement. Construction of monitoring and extraction wells and a treatment facility are proven technologies. Groundwater monitoring would follow EPA approved procedures and all the equipment are readily available.
Present Worth with Discounting	$0	$2.29 million	$13.16 million

Table 5-2
Summary of the Duration of Groundwater Alternatives
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

Item Description	Alternative 1	Alternative 2	Alternative 3
	No Action *	Limited Action	Pump and Treat
	year	year	year
Contaminant Concentrations in the Entire Plume meet PRGs	46	46	35
Contaminant Concentrations less than 1 µg/L in supply wells GWP-10 and GWP-11	15	15	10
Long-term Monitoring Program and Five-year Reviews **	46	46	35

Notes:
The effective porosity is assumed to be 0.15 for all the alternatives.
* Under No Action alternative, the future operation of supply wells GWP-10 and GWP-11 will be the same as the current conditions.

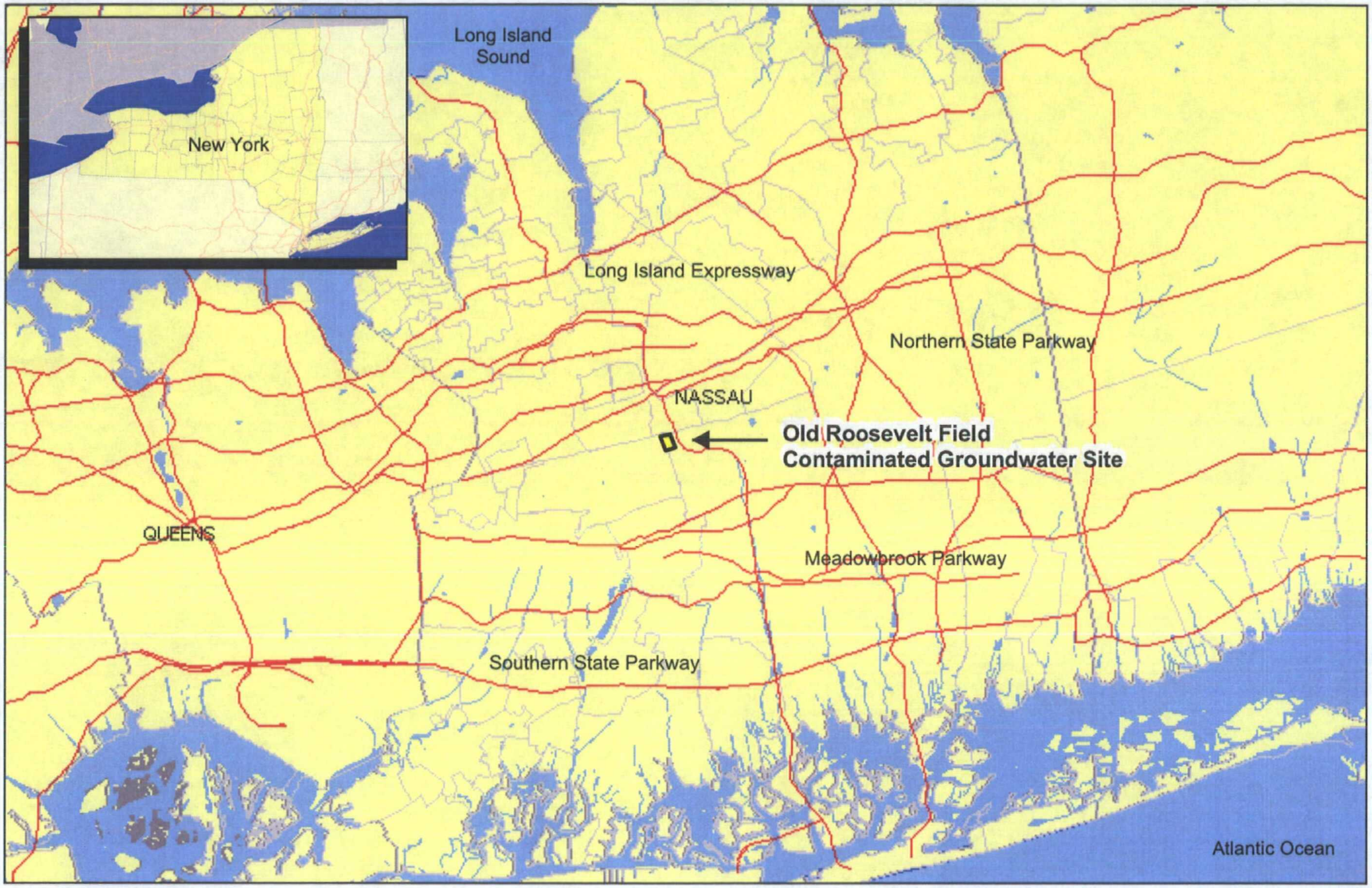
** Under Alternative 2 and Alternative 3, the scale of long-term monitoring may be reduced after the size of the contaminant plume is significantly reduced.

Table 5-3
Cost Comparison of Groundwater Alternatives
Old Roosevelt Field Contaminated Groundwater Superfund Site
Garden City, New York

Item Description	Alternative 1	Alternative 2	Alternative 3	Contingency
	No Action	Limited Action	Pump and Treat	Pump-and-Treat
	$ Million	$ Million	$ Million	$ Million
Total capital costs	0	0.30	6.24	5.66 (a)
Annual O&M costs for Treatment	0	0.00	0.68	0.68
Long-term Monitoring Program Annual Cost [1]	0	0.15/0.11	0.17/0.11	NA
Total present worth of annual or periodic costs (with discounting)	0	1.99	6.92	NA
Total present worth of project costs (with discounting)	0	2.29	13.16	NA

Note:
1. For Alternative 2 and 3, the scale of long-term monitoring program will be reduced after 25 years.
a. The capital cost for the contingency pump and treat system includes design, groundwater modeling, and construction.
NA: Not applicable because the duration is unknown.
The total present worth cost is calculated without inflation.

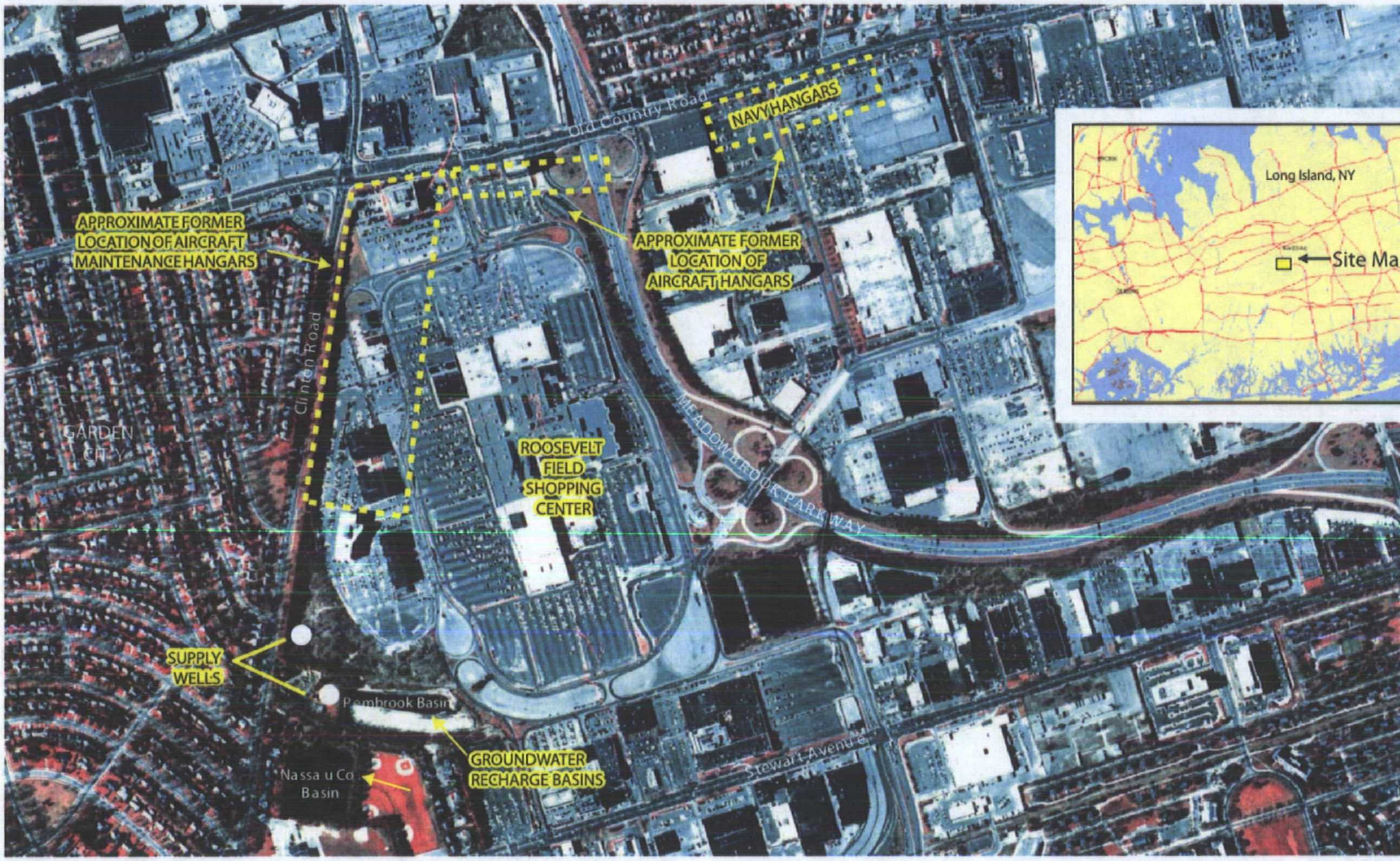
Figures



adapted from NYSDEC Interactive Mapping Gateway: http://www.nygis.state.ny.us/gateway/index.html

CDM

Figure 1-1
Site Location Map
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

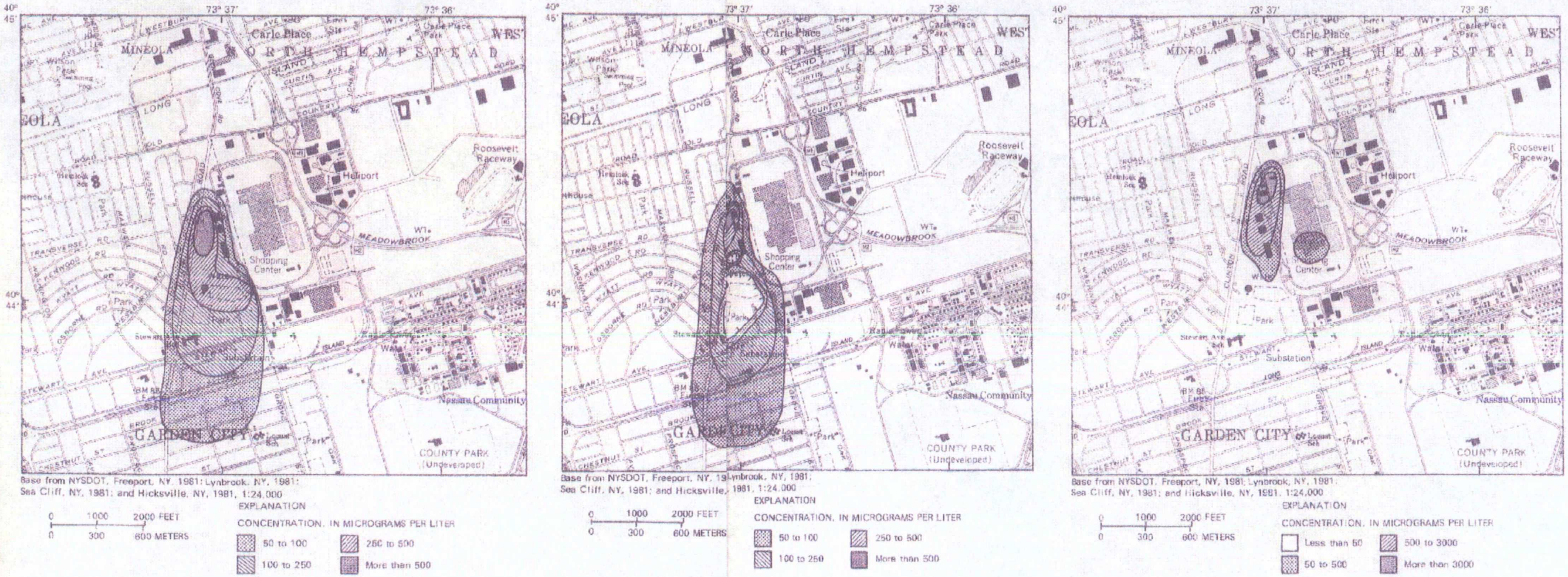


adapted from NY SDEC Interactive Mapping Gateway: http://www.nygis.state.ny.us/gateway/index.html

CDM

0.25 0.125 0 0.25 Miles

Figure 1-2
Site Map
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York



(a) **TCE concentrations in the Upper Glacial Aquifer (Summer 1983)**

(b) **TCE concentratiIs in the Upper Glacial Aquifer (Spring 1984)**

(c) **TCE concentrations in the Magothy Aquifer (Spring 1984)**

from Eckhardt and Pearsall (1989)

Figure 1-3
Historical Groundwater Plume Map
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CDM

C:\IMS\GIS\Roosevelt Field\ArcMap_projects\Well_locations.mxd

Existing Monitoring Wells

Multi-port Wells

Supply Wells

N-8050 - A former cooling water well in which the highest concentrations were historically detected; the well is no longer active

N

0 260 520 1,040 Feet

Figure 1-4
Multi-port Well, Existing Monitoring Well, and Supply Well Locations
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CDM

C:\IMS\GIS\Roosevelt Field\ArcMap_projects\Soil_gas_screening_locations.mxd

Soil Gas Screening Grid Point Location

N

0 75 150 300 450 600 Feet

Figure 1-5a
Soil Gas Screening Locations
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CDM

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Figure 1-5b
Soil Gas Analytical Sample Locations
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CDM

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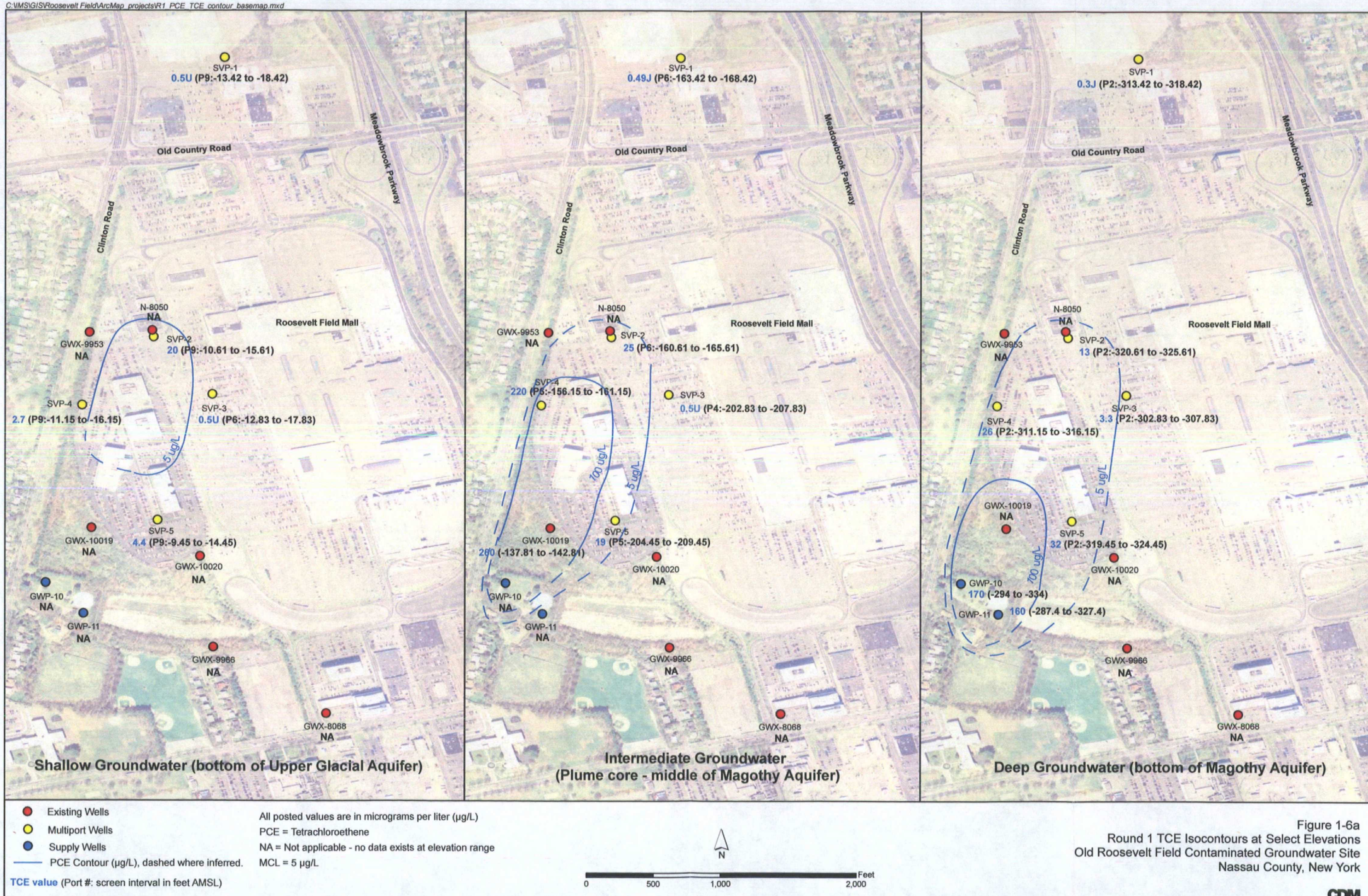

Figure 1-6a
Round 1 TCE Isocontours at Select Elevations
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York

CDM

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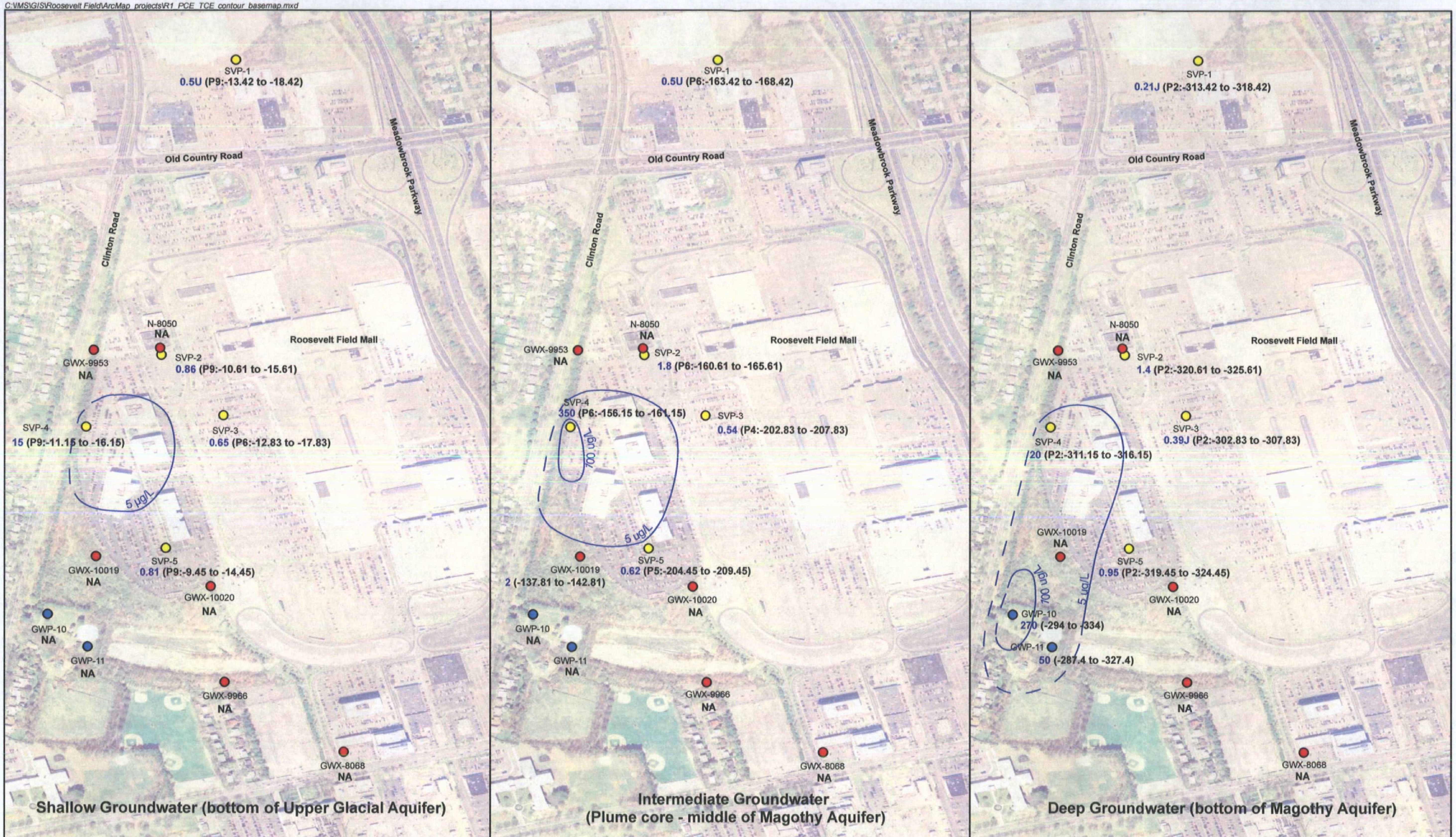


- Existing Wells
- Multiport Wells
- Supply Wells
- PCE Contour (µg/L), dashed where inferred

PCE value (Port #: screen interval in feet AMSL)

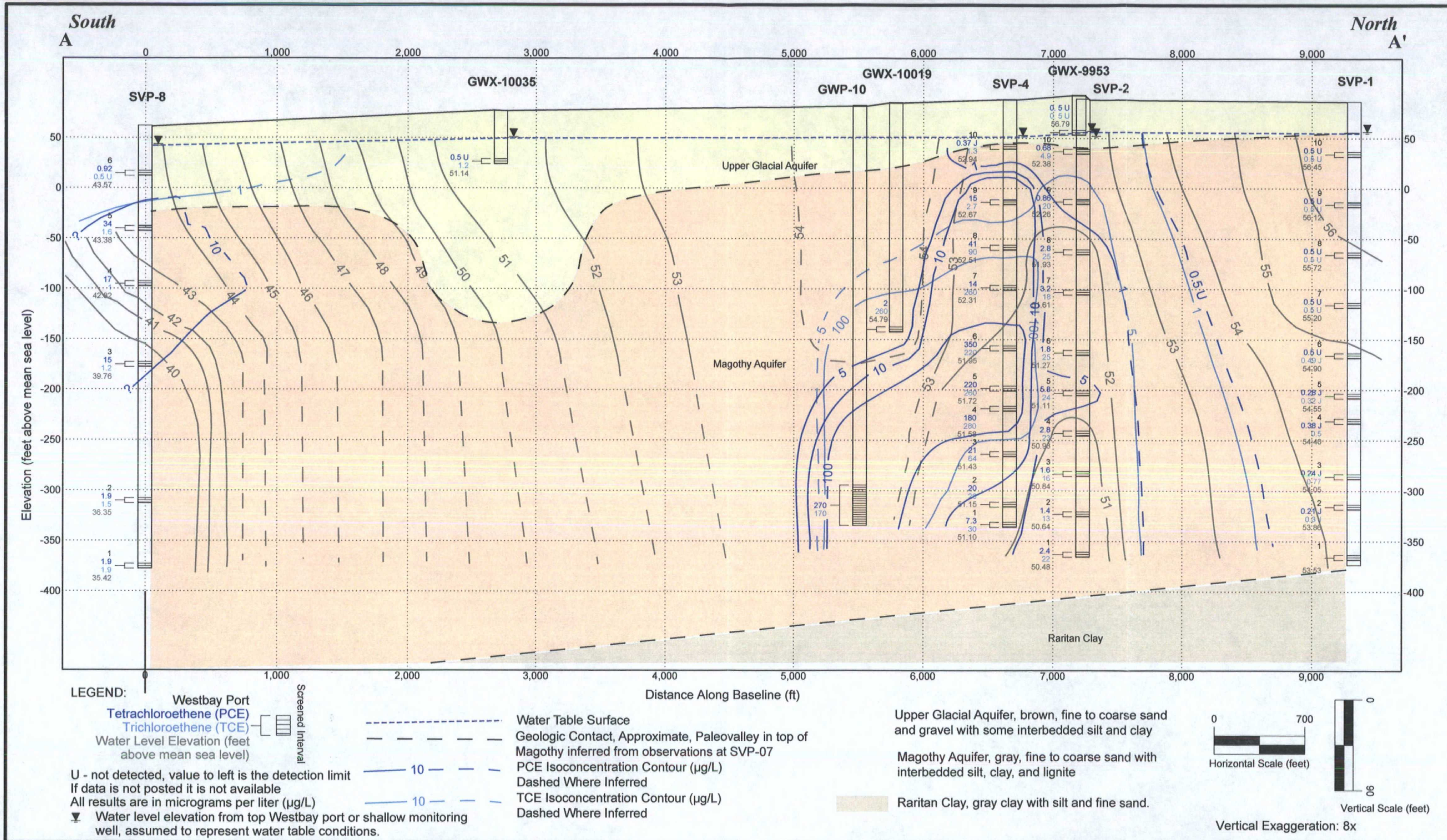
All posted values are in micrograms per liter (µg/L)
PCE = Tetrachloroethene
NA = Not applicable - no data exists at elevation range
MCL = 5 µg/L

N

0 500 1,000 2,000 Feet

Figure 1-6b
Round 1 PCE Isocontours at Select Elevations
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York

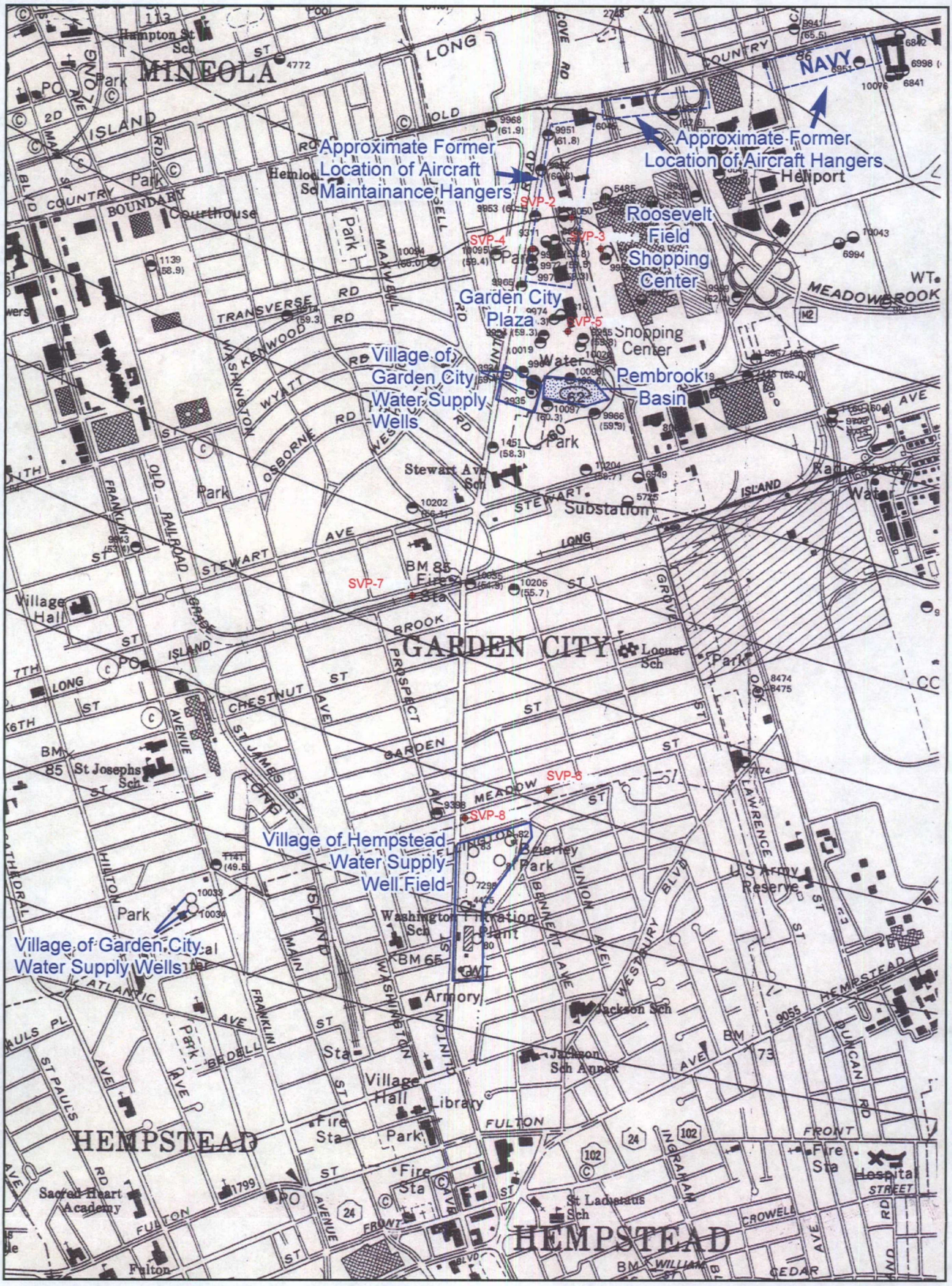
CDM



MULTIPORT WELL FENCE DIAGRAM ROOSEVELT.GPJ ROOSEVELT.GDT 11/07/06 REV.

CDM

Figure 1-7
Round 1 PCE/TCE Plume Cross-Section Map
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York



adapted from Eckhardt and Pearsall (1989)

9951 (61.8)	OBSERVATION WELL AND LOCAL NUMBER--Number in parentheses is water-table altitude on April 25, 1984, in feet. Datum is mean sea level
5485	PUBLIC WATER-SUPPLY WELL AND LOCAL NUMBER
8050	COOLING-WATER WELL AND LOCAL NUMBER
54	LINE OF EQUAL WATER-TABLE ALTITUDE IN UPPER GLACIAL AQUIFER--Dashed where approximately located. Contour interval 2 feet. Datum is mean sea level
	PART OF MITCHEL FIELD AREA EXCLUDED FROM THIS STUDY

N

SVP-5 CDM INSTALLED MONITORING WELLS

Figure 1-8
Multi-port Wells in Relation to Hempstead Well Field

Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CDM

C:\IMS\GIS\Roosevelt Field\ArcMap_projects\Roosevelt 15 ft Screening Results.mxd

- Soil gas screening point with grid point number and screening reading in parts per billion per volume (ppbv)
- Soil gas screening point with outdoor building boring location number
- Screening results at location exceed 10 ppbv
- Existing Wells and Multi-port Wells Included for Spatial Reference

Notes: H19 and H18 were combined at location H-19
bgs = below ground surface
All soil gas measurements were made with a ppbRAE

N

0 125 250 500 Feet

Figure 1-9
Soil Gas Total VOC Screening Results - 15 feet bgs
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

C:\MS\GIS\Roosevelt Field\ArcMap_projects\Roosevelt 35 ft Screening Results_revised.mxd

- Soil gas screening point with grid point number and screening reading in parts per billion per volume (ppbv)
- Soil gas screening point with outdoor building boring location number
- Screening results at location exceed 10 ppbv
- Existing Wells and Multi-port Wells Included for Spatial Reference

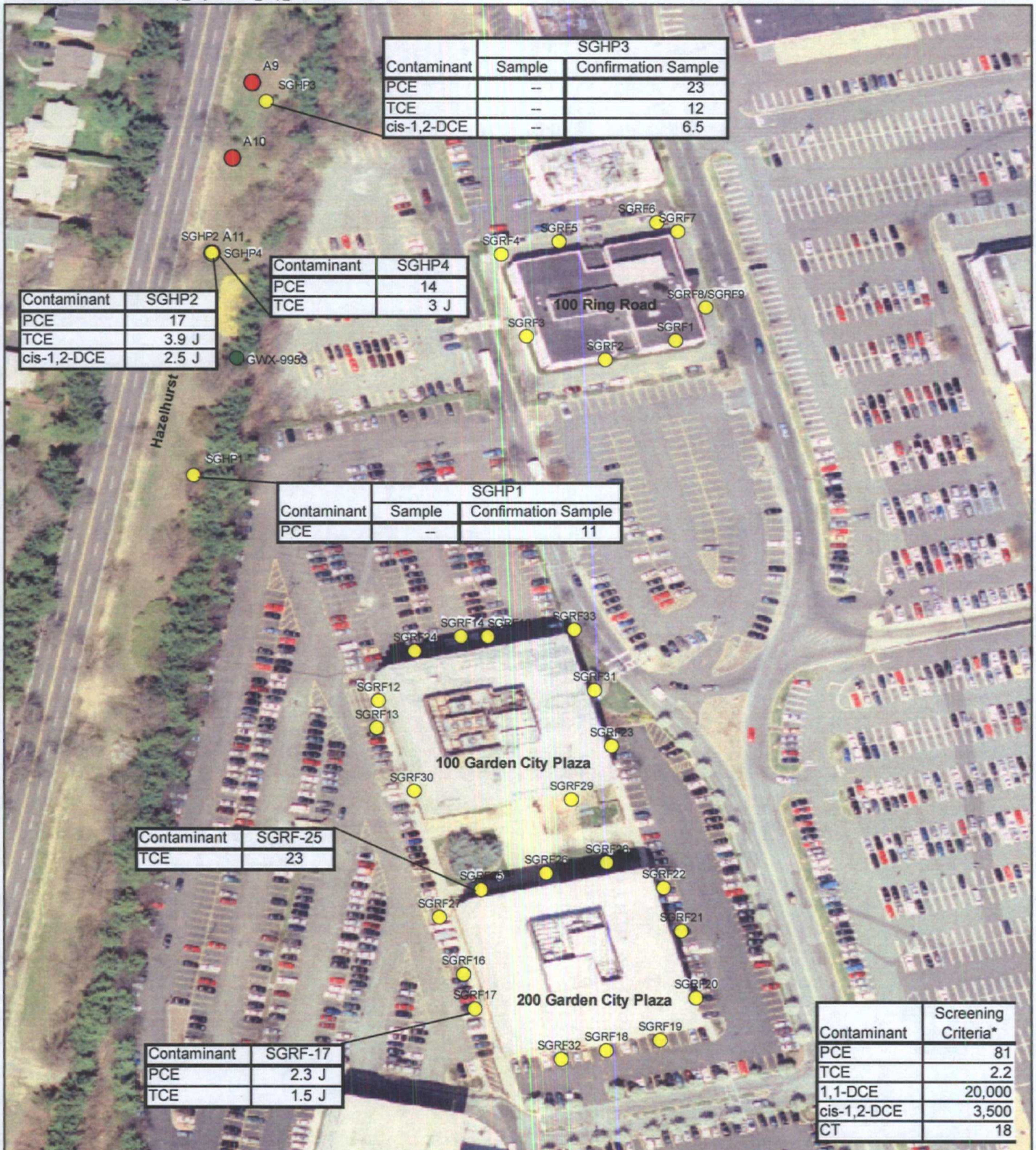
Notes: H19 and H18 were combined at location H-19
bgs = below ground surface
All soil gas measurements were made with a ppbRAE

N

0 145 290 580 Feet

Figure 1-10
Soil Gas Total VOC Screening Results - 35 feet bgs
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

C:\IMS\GIS\Roosevelt Field\ArcMap_projects\base_map_boxes.mxd



Contaminant	SGHP3	
	Sample	Confirmation Sample
PCE	--	23
TCE	--	12
cis-1,2-DCE	--	6.5

Contaminant	SGHP4
PCE	14
TCE	3 J

Contaminant	SGHP2
PCE	17
TCE	3.9 J
cis-1,2-DCE	2.5 J

Contaminant	SGHP1	
	Sample	Confirmation Sample
PCE	--	11

Contaminant	SGRF-25
TCE	23

Contaminant	SGRF-17
PCE	2.3 J
TCE	1.5 J

Contaminant	Screening Criteria*
PCE	81
TCE	2.2
1,1-DCE	20,000
cis-1,2-DCE	3,500
CT	18

Soil Gas Boring Location, collected at 15 feet bgs,for VOC Analysis via method TO-15

Existing Monitoring Wells and Multi-port Wells Included for Spatial Reference

Notes
SGRF10 and SGRF11 were not collected due to underground utilities.
Screening sample locations A9, A10, and A11 are included for reference.

J = Estimated Value
U = Non Detect
CT = Carbon Tetrachloride
PCE = Tetrachloroethene
TCE = Trichloroethene
1,1-DCE = 1,1 Dichloroethene
cis-1,2-DCE = cis-1,2-Dichloroethene

N

Feet
0 50 100 200

Figure 1-11
TO-15 Site-Related VOC Results - Outdoor Building Soil Gas Samples

Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

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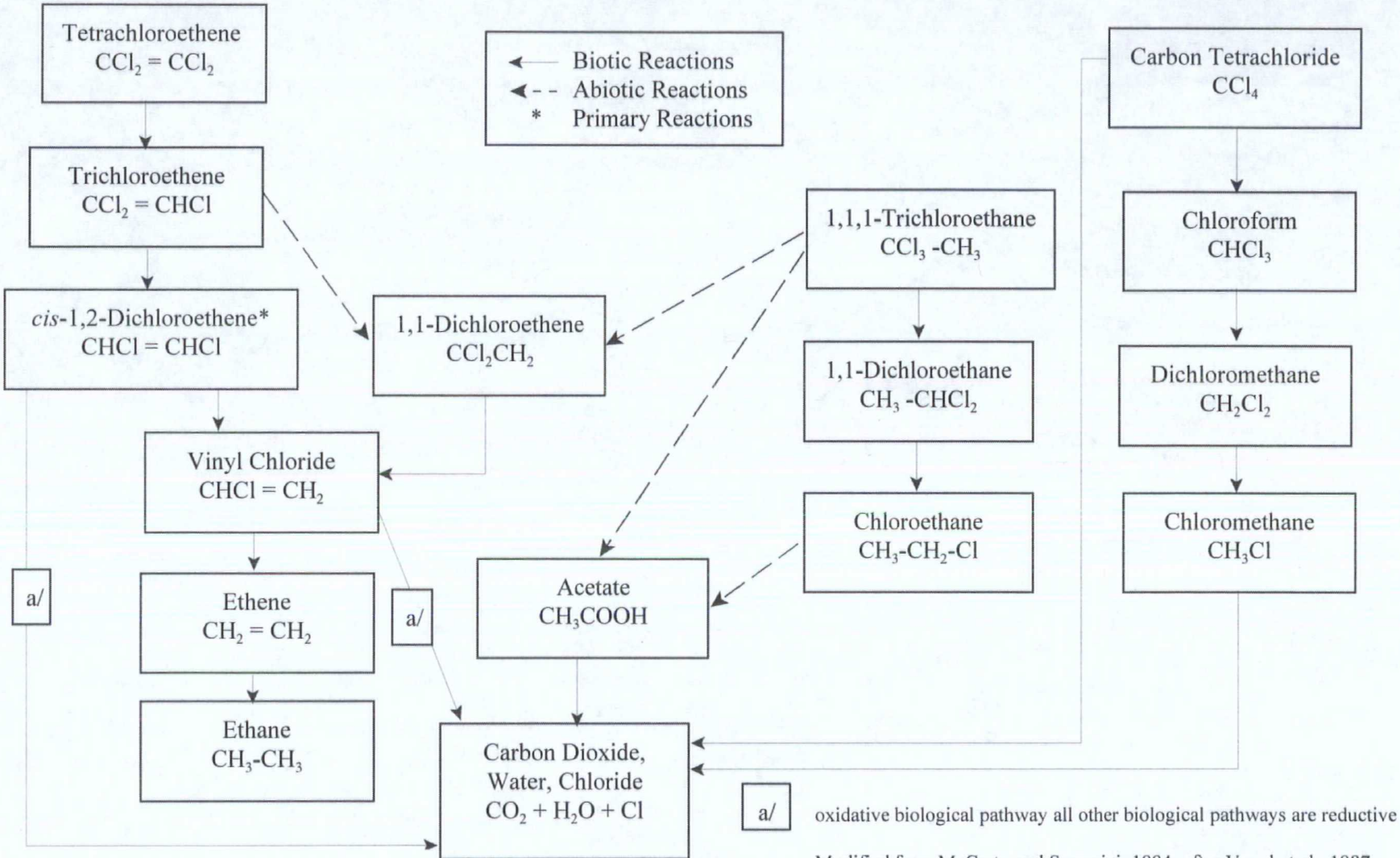


oxidative biological pathway all other biological pathways are reductive

Modified from McCarty and Semprini, 1994; after Vogel et al., 1987

CDM

Figure 1-12
Abiotic and Biological Transformation Pathways for Selected Chlorinated Solvents
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

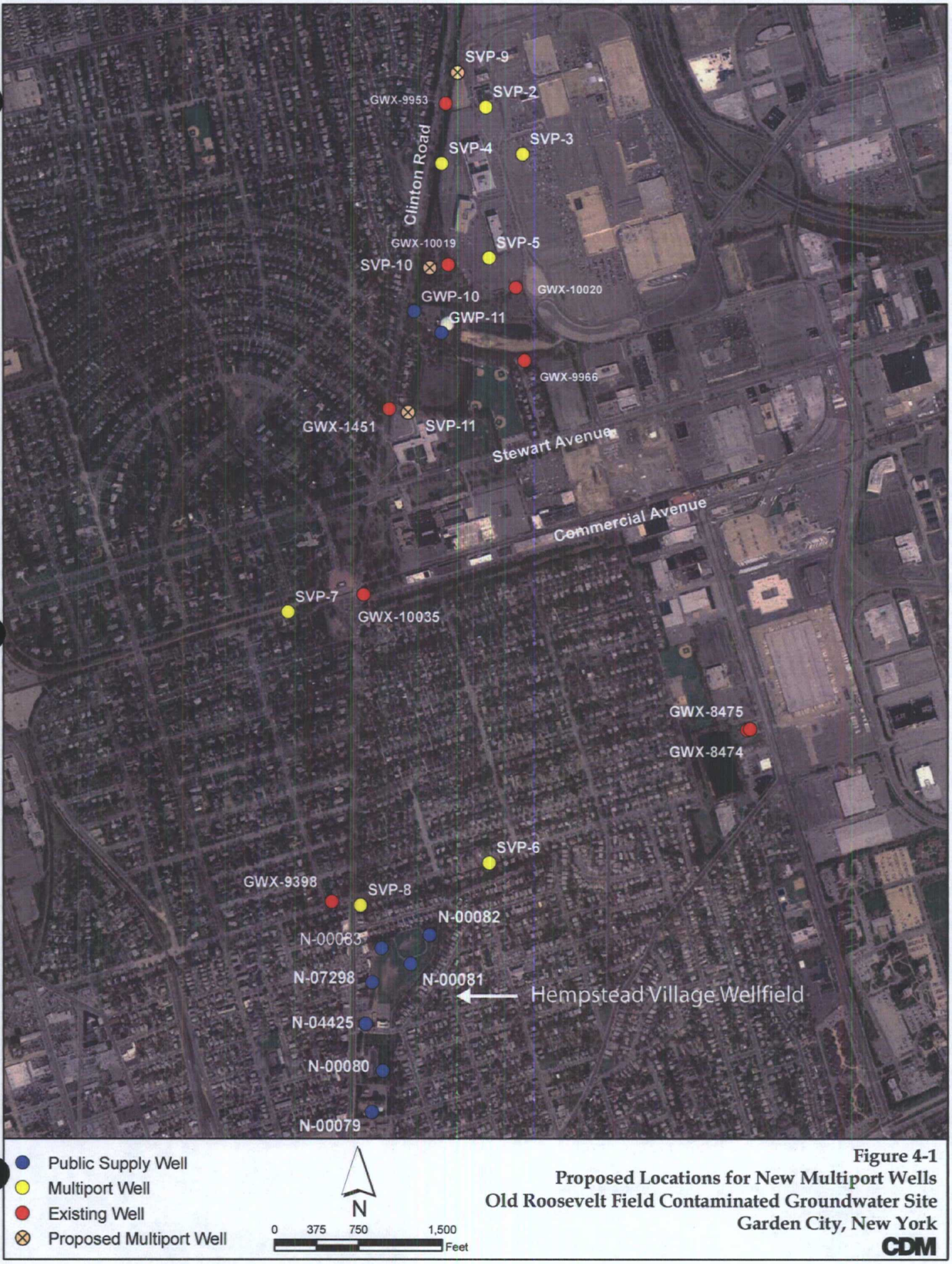


Figure 4-1
Proposed Locations for New Multiport Wells
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York
CDM

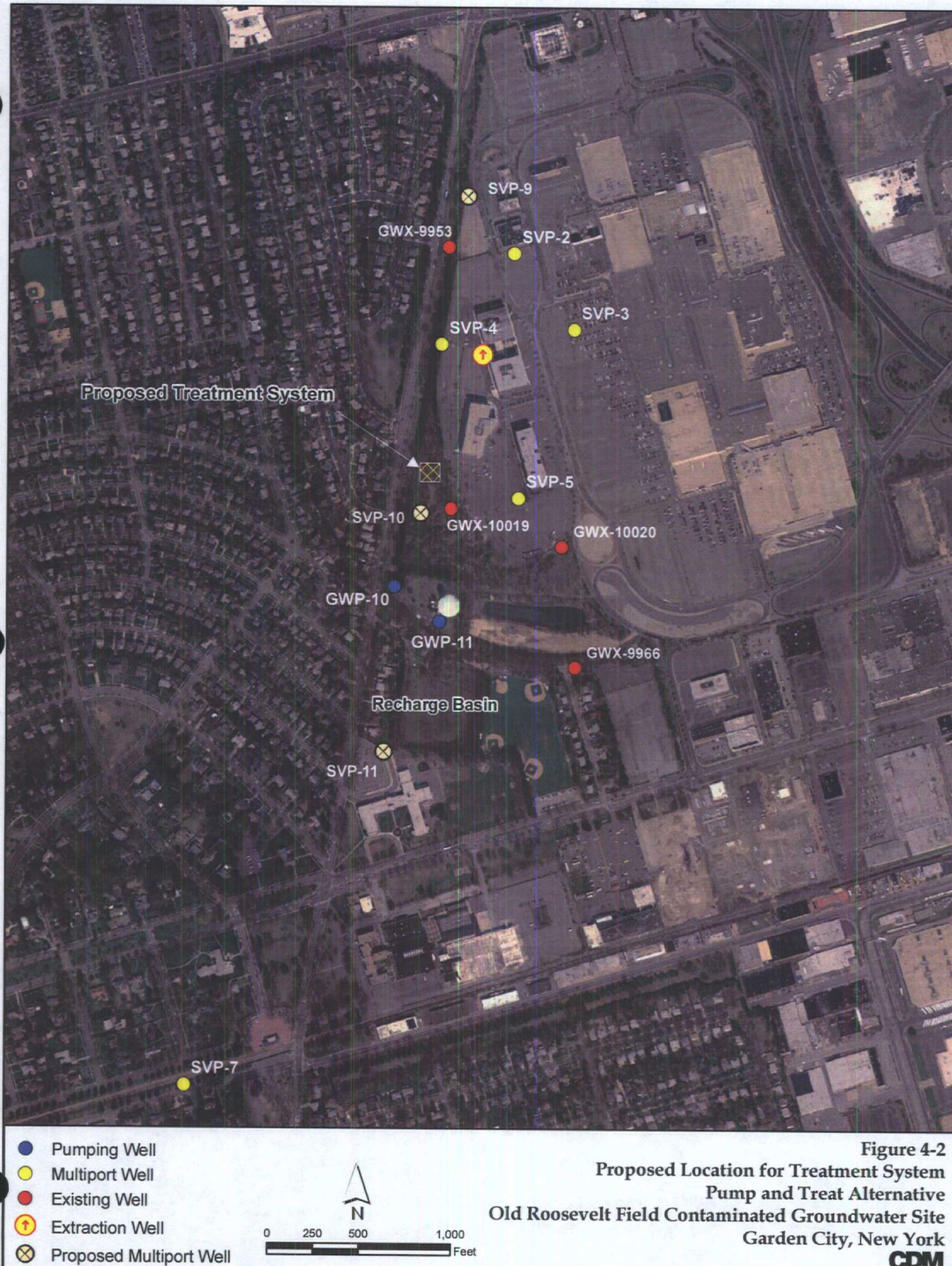
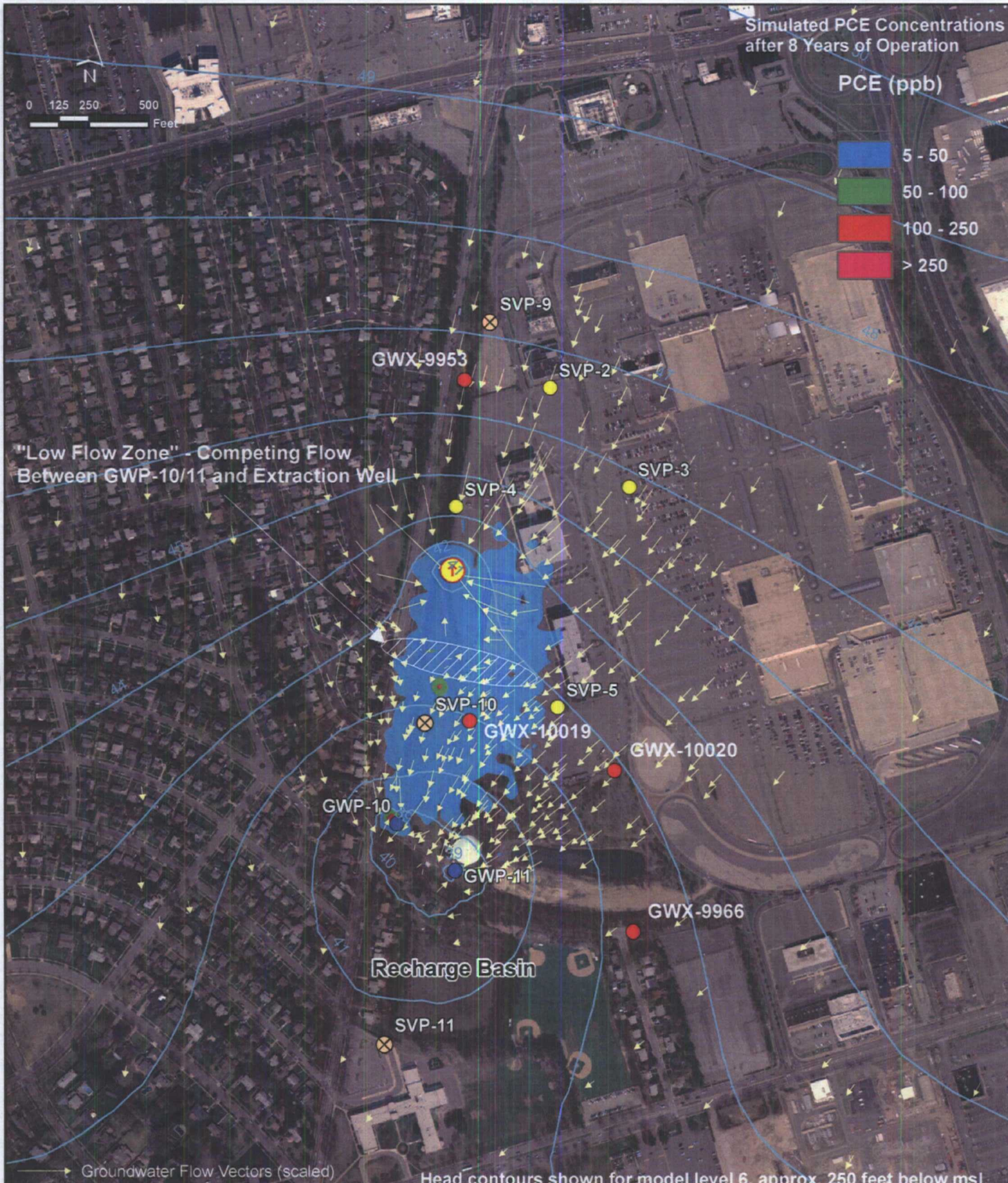


Figure 4-2
Proposed Location for Treatment System
Pump and Treat Alternative
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York
CDM



- Public Supply Well
- Multiport Well
- Existing Well
- Extraction Well
- Proposed Multiport Well
- Potentiometric Surface (ft, msl)

Figure 4-3
Pump and Treat Alternative - Pumping 150 gpm from Extraction Well
"Low Flow Zone" between Extraction and Garden City Wells
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York

CDM

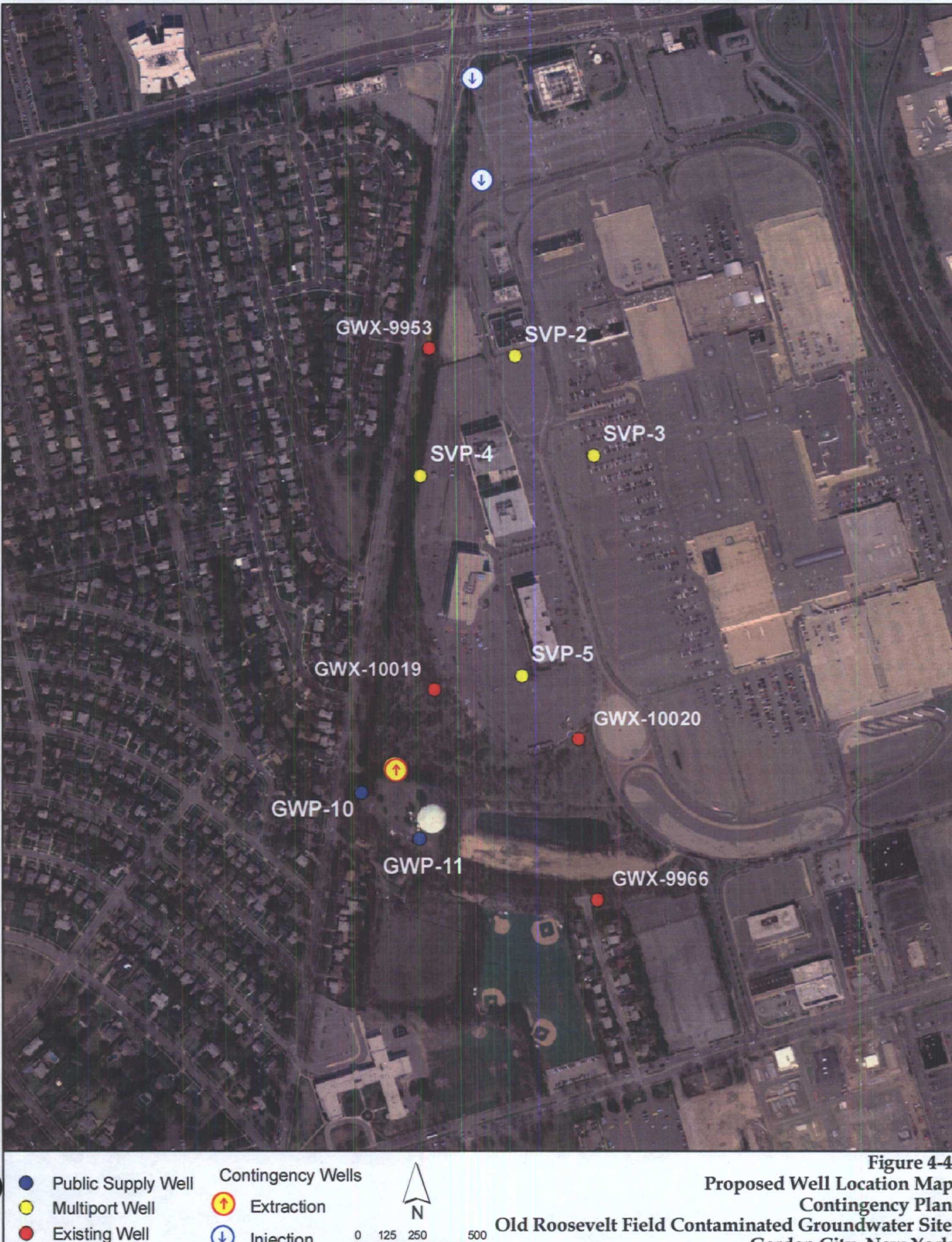


Figure 4-4
Proposed Well Location Map
Contingency Plan
Old Roosevelt Field Contaminated Groundwater Site
Garden City, New York
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Appendix A

Appendix A

Preliminary Groundwater Model Memorandum

CDM

Memorandum

To: *Susan Schofield, Grace Chen, Thomas Mathew, and Ali Rahmani*

From: *Dan O'Rourke, Bob Fitzgerald, and Karilyn Heisen*

Date: *Monday, August 13, 2007*

Subject: *Old Roosevelt Field Groundwater Model and Transport Simulations*

A groundwater model was developed for the Old Roosevelt Field contaminated groundwater site in Nassau County, New York to evaluate several remedial scenarios for the Feasibility Study (FS), which is currently being developed by CDM. This technical memorandum documents the development of the groundwater model and the various transport simulations that were conducted to support the FS.

Model Development

The Old Roosevelt Field groundwater flow model was adapted from the existing Nassau County regional model (NCRM). The NCRM was developed and calibrated by CDM for Nassau County Department of Public Works in 1990 (CDM, 1990) and was recently updated for the New York State Source Water Assessment Program (SWAP; NYSDOH, 2003). Updates to the model incorporated additional geologic information and details from various sub-regional models and USGS investigations since the original model was developed. It has since been the basis of numerous modeling studies in Nassau County, addressing water supply planning and management, saltwater intrusion, streamflow maintenance and augmentation, nitrate contamination, and remediation of VOC and hydrocarbon plumes. A number of local, or sub-regional, models have been created based on the NCRM. A version of the NCRM recently updated for an industrial site in northern Nassau County was the starting point for this study.

Modeling Codes

DYNSYSTEM groundwater modeling software was utilized, including DYNFLOW (single-phase groundwater flow) and DYNTRACK (solute transport).

DYNFLOW

DYNFLOW is a fully three-dimensional, finite element groundwater flow model. This model has been developed over the past 25 years by CDM engineering staff, and is in general use for large scale basin modeling projects and site specific remedial design investigations around the world. It has been applied to more than 200 groundwater modeling studies in the United States, including a number of Long Island studies. The DYNFLOW code has been reviewed and tested by the International Groundwater Modeling Center (IGWMC) (van der Heijde 1985, 1999) and has been extensively tested and documented by CDM.

The governing equation for three-dimensional groundwater flow that is solved by DYNFLOW is:

$$S_s \frac{\partial \phi}{\partial t} = \frac{\partial}{\partial x_i} K_{ij} \frac{\partial \phi}{\partial x_j} ; i, j = 1, 2, 3$$

where the state variable φ represents the potentiometric head [L]; K_{ij} represents the hydraulic conductivity [LT^{-1}] tensor; S_s is the specific storativity (volume/volume/length), [L^{-1}]; x_j is a Cartesian coordinate and t is time.

DYNFLOW uses a grid built with a large number of tetrahedral elements. These elements are triangular in plan view, and give a wide flexibility in grid variation over the area of study. This allows important features to be represented with a fine degree of detail. An identical grid is used for each level of the model, but the thickness of each model layer (the vertical distance between levels in the model) can vary at each point in the grid. In addition, 2-dimensional elements can be inserted into the basic 3-dimensional grid to simulate thin features such as faults. One-dimensional elements can be used to simulate the performance of wells which are perforated in several model layers.

DYNFLOW accepts various types of boundary conditions on the groundwater flow system including:

- Specified head boundaries (where the piezometric head is known, such as at rivers, lakes, ocean, or other points of known head)

- Specified flux boundaries (such as rainfall infiltration, well pumpage, and no-flow "streamline" boundaries)

- Rising water boundaries; these are hybrid boundaries (specified head or specified flux boundary) depending on the system status at any given time. Generally used at the ground surface to simulate streams, wetlands, and other areas of groundwater discharge.

- Head-dependent flux (3rd type) boundaries including "river" and "general head" boundary conditions.

DYNTRACK

DYNTRACK is the companion solute transport code to DYNFLOW. DYNTRACK uses the random-walk technique to solve the advection-dispersion equation within groundwater flow fields computed by DYNFLOW. DYNTRACK has been developed over the past 20 years by CDM engineering staff. It has been applied at numerous groundwater remediation sites on Long Island and Superfund sites nationwide.

The partial differential equation describing transport of conservative solutes in a groundwater flow field is:

$$n_e \frac{\partial C}{\partial t} = \frac{\partial}{\partial x_i} n_e D_{ij} \frac{dC}{dx_j} - q_i \frac{dC}{dx_i} ; i, j = 1, 2, 3$$

where C is the concentration at any x_i location, n_e is the effective porosity, q_i is the specific discharge vector, and D_{ij} is the dispersion tensor. The first term on the right hand side of the equation represents the dispersive flux as embodied by Fick's Law; the second term represents the advective flux of solute mass.

DYNTRACK uses a Langrangian approach to approximate the solution of the partial differential equation of transport. This process uses a random walk method to track a statistically significant number of particles, wherein each particle is advected with the mean velocity within a grid element and then randomly dispersed according to specified dispersion parameters. DYNTRACK also simulates solute retardation assuming linear, instantaneous equilibrium adsorption and 1st order decay of solute mass.

In DYNTRACK, a solute source can be represented as an instantaneous input of solute mass (represented by a fixed number of particles), as a continuous source on which particles are input at a constant rate, or as a specified concentration at a node. The concentration within a particular zone of interest is represented by the total number of particles that are present within the zone multiplied by their associated solute mass, divided by the volume of water within the zone. DYNTRACK has also been reviewed and tested by the IGWMC (van der Heijde 1985). Additional review and testing of both DYNFLOW and DYNTRACK can be found in Pandit et al (1997).

Model Framework and Grid

The domain of the Nassau County Regional Model extends across Queens and Nassau Counties, and into the western portion of Suffolk County. The model grid consists of triangular elements and the grid is denser in Nassau County, which was the focus of the groundwater flow model. For the Old Roosevelt Field modeling effort, additional elements were added near the site, particularly near the Garden City public supply wells. The additional discretization reduced element size within the vicinity of the Old Roosevelt Field site from around 500 feet in areas outside the property to approximately 10 feet at the supply wells. The finite element grid is shown on Figure 1.

The boundaries of the grid extend north to the Long Island Sound and south beyond the barrier islands along the south shore. The northern and southern boundary conditions are assigned as specified head in which heads at the surface are assigned an elevation of mean sea level. At depth, specified heads at the boundaries are assigned equivalent fresh water head values (greater than mean sea level) that account for the greater density of salt water. The western model boundary extends to the Kings/Queens County line. This boundary was simulated using a no-flow boundary condition as it is far enough away from the Old Roosevelt Field site to have any impact on groundwater flow within the vicinity of the site. The eastern model boundary extends into Suffolk County to the Nissequoge and Connetquot Rivers; the eastern boundary is simulated using a specified head boundary condition at the surface to represent the interaction of groundwater with the surface water, and a no-flow boundary condition below the surface.

The Nassau County Regional Groundwater Model is divided vertically into eight layers (defined by nine "levels" of nodes at the top and bottom of the layers). Near the site, the flow model includes the major aquifers and confining units (Lloyd aquifer, Raritan clay, Magothy aquifer and upper glacial aquifer). The regional model stratigraphy was developed based on boring logs, structural contour maps, and cross sections developed by the USGS (Smolensky et al., 1989). In some cases, the units are subdivided into lower and upper subgroups to better represent lithologic units within the aquifer, and to achieve a better representation of flow and heads in the model. For example, the Magothy aquifer is sub-divided into upper, middle and basal units. The basal unit is a coarser unit and therefore has a higher hydraulic conductivity. This coarser "basal Magothy" occurs throughout most of Long Island and is documented by the USGS (Smolensky et al., 1989).

Adjustments to the regional flow model for the Old Roosevelt Field model include adding two computational layers to the Magothy to provide increased vertical discretization near the Garden City public supply wells and potential extraction wells upgradient. The old Roosevelt Field model has a total of ten layers and eleven levels. Model stratigraphy was compared to cross-sections developed for the RI as well as cross-sections and boring log information from the USGS (Eckhardt and Pearsall 1989). Adjustments to the stratigraphy included lowering the surface elevation to match elevations at multi-port wells and raising the surface of the coarser basal Magothy. In addition, a buried valley where the upper glacial-Magothy contact is locally deepened was added to the model near GWX-10035 and SVP-07, as

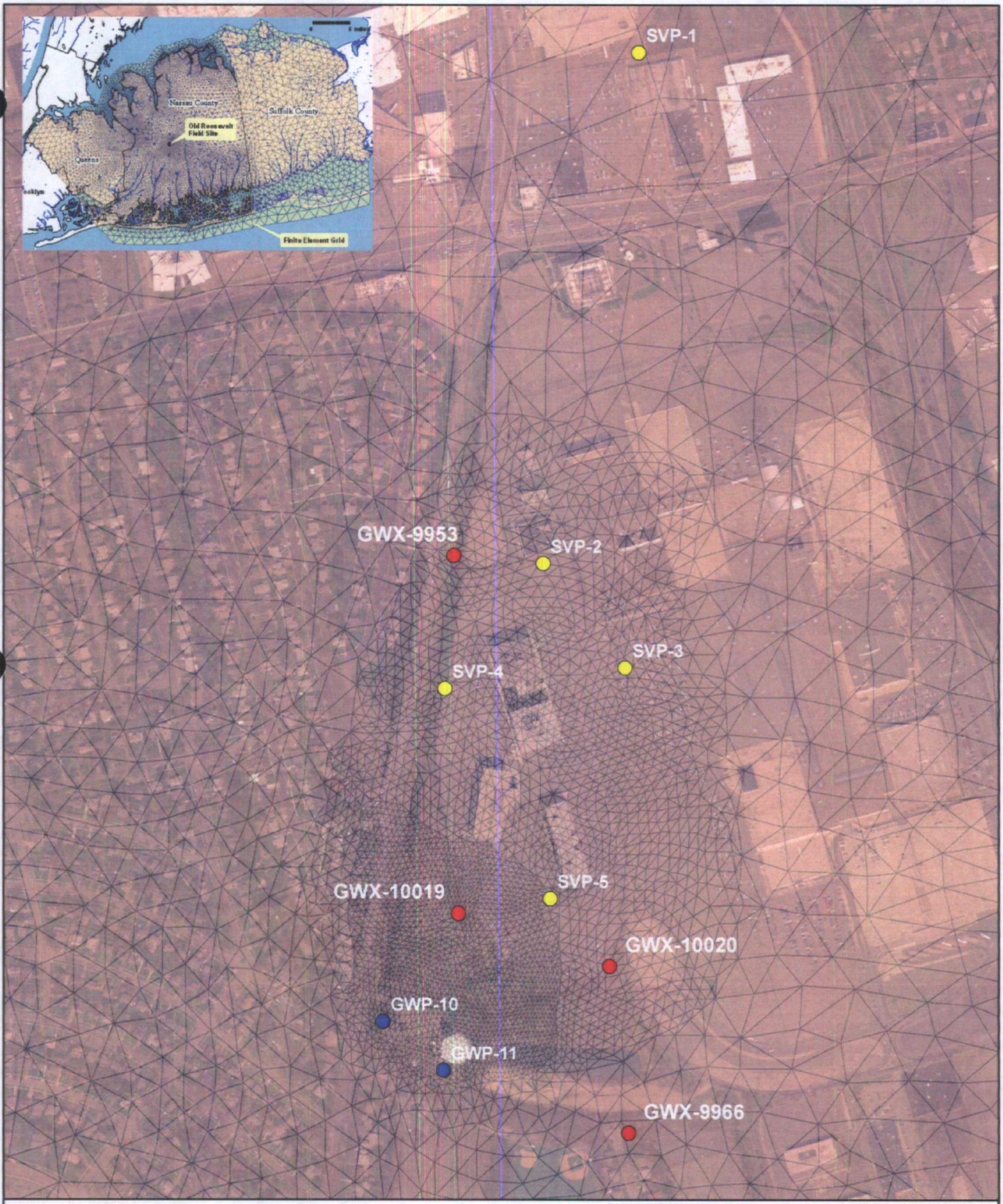


Figure 1
Finite Element Grid
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York
CDM

suggested in the RI. A cross-section is shown on Figure 2. The extent of this valley is unknown, but it was incorporated into the model in a general region within the study area.

Active pumping wells are represented in the model by specified fluxes at nodes that correspond to the vertical and horizontal coordinates of each well. The model incorporates pumping from public water supply wells as well as from non-residential commercial and industrial properties.

The main source of groundwater recharge to the model area is precipitation infiltration; however, the amount of groundwater recharge applied to a given area depends on the land use in the area, and impervious cover. To account for this variation, the application of groundwater recharge to the model was varied according to the land use of a given area, and took into account other potential sources of groundwater recharge such as recharge basins, septic systems and leaking water mains. The amount of groundwater recharge available within the watersheds of major streams was reduced by a stream runoff coefficient. Runoff coefficients for gaged streams in Nassau County are specified by Ku et al (1992). Precipitation data collected from the Mineola weather station were used in the model simulation. The long term average precipitation rate at this station is approximately 44 inches per year.

After adjustments to grid discretization and stratigraphy, the model was run in a transient simulation, using monthly time steps of pumping and recharge. The model simulation ran between 1995-2005 and simulated water levels at selected monitoring wells within the vicinity of the Old Roosevelt Field site were compared to water level data collected by Nassau County Department of Public Works (NCDPW, 2002) to verify that previous calibrations of the model were not negatively impacted (Figure 3).

Although groundwater head data were collected from the on-site multiport wells during the RI, the groundwater model was not calibrated to these heads. The data were collected during 2006 and groundwater pumpage data from nearby water supply wells were not available at the time this model was developed. In 2006, there were 335 active public supply wells in Nassau County (NCDPW, 2007). Since there are several supply wells from various water purveyors that are located within the vicinity of the Old Roosevelt Field site (Figure 4), pumpage from these supply wells can have an impact on groundwater head and gradient near the site. Without 2006 pumpage for all surrounding public supply wells, calibration to heads collected onsite in 2006 could not be conducted.

Although the model was unable to be calibrated to the 2006 data collected at the multiport wells, the model was based from an existing calibrated model and differences between simulated and observed heads between 1995-2005 at nearby monitoring wells are acceptable. Therefore, this model is suitable for the FS-level transport simulations (discussed below). A general plan view of the water table and groundwater flow direction is shown on Figure 5a for June 2004. Figure 5b shows the simulated potentiometric surface and flow direction in the

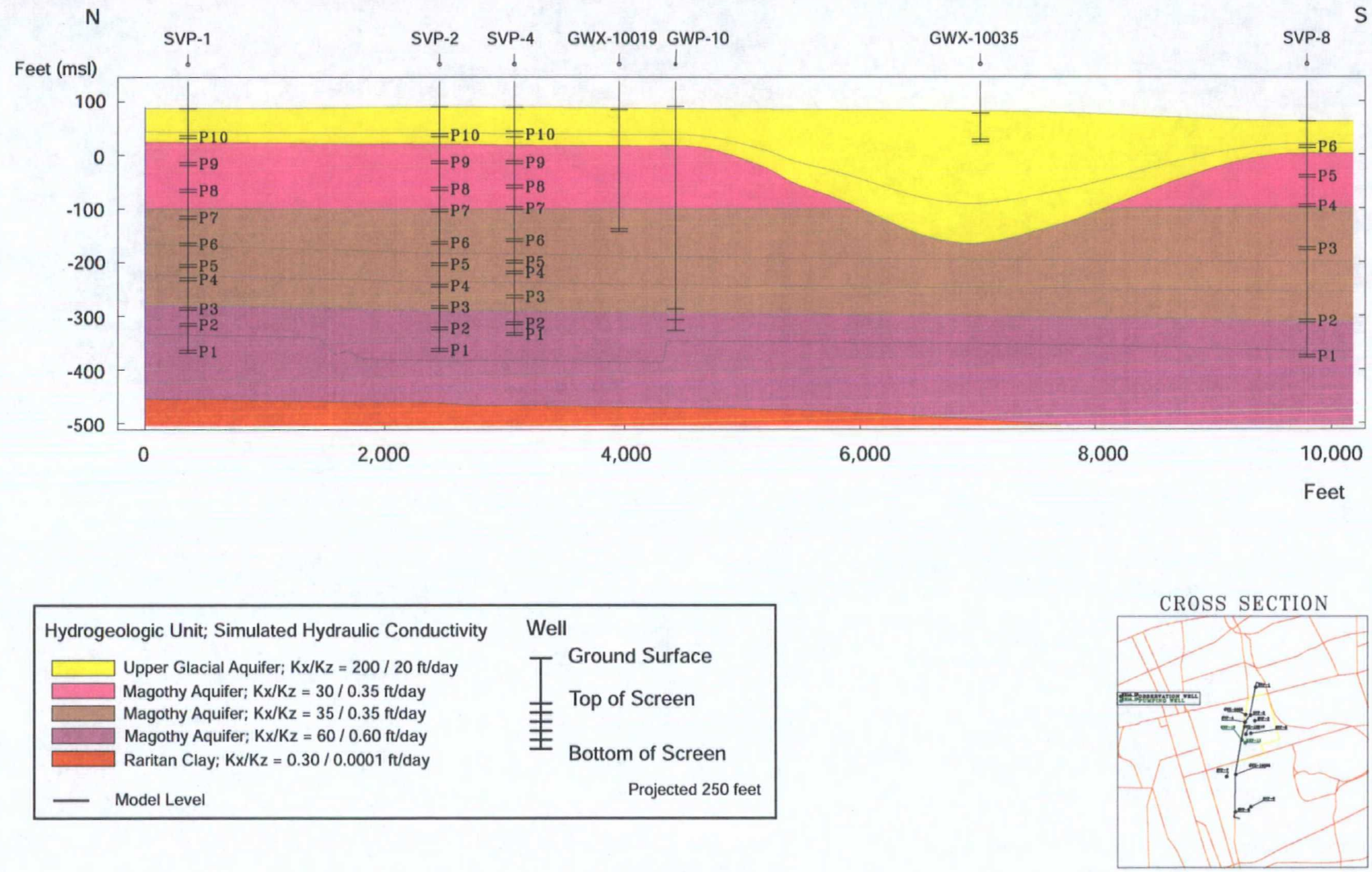


Figure 2
Old Roosevelt Field Groundwater Model
Stratigraphic Cross-Section
CDM

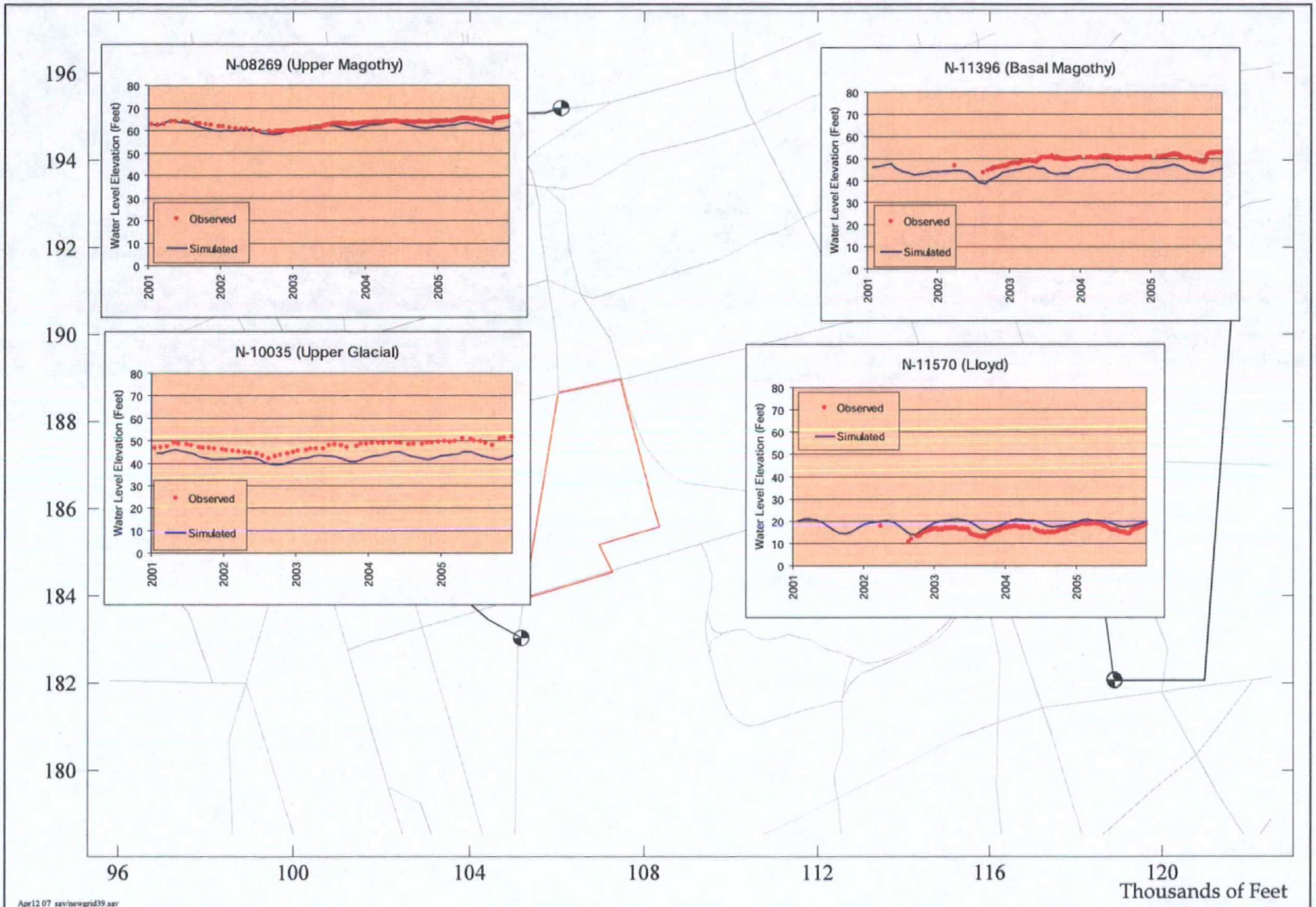
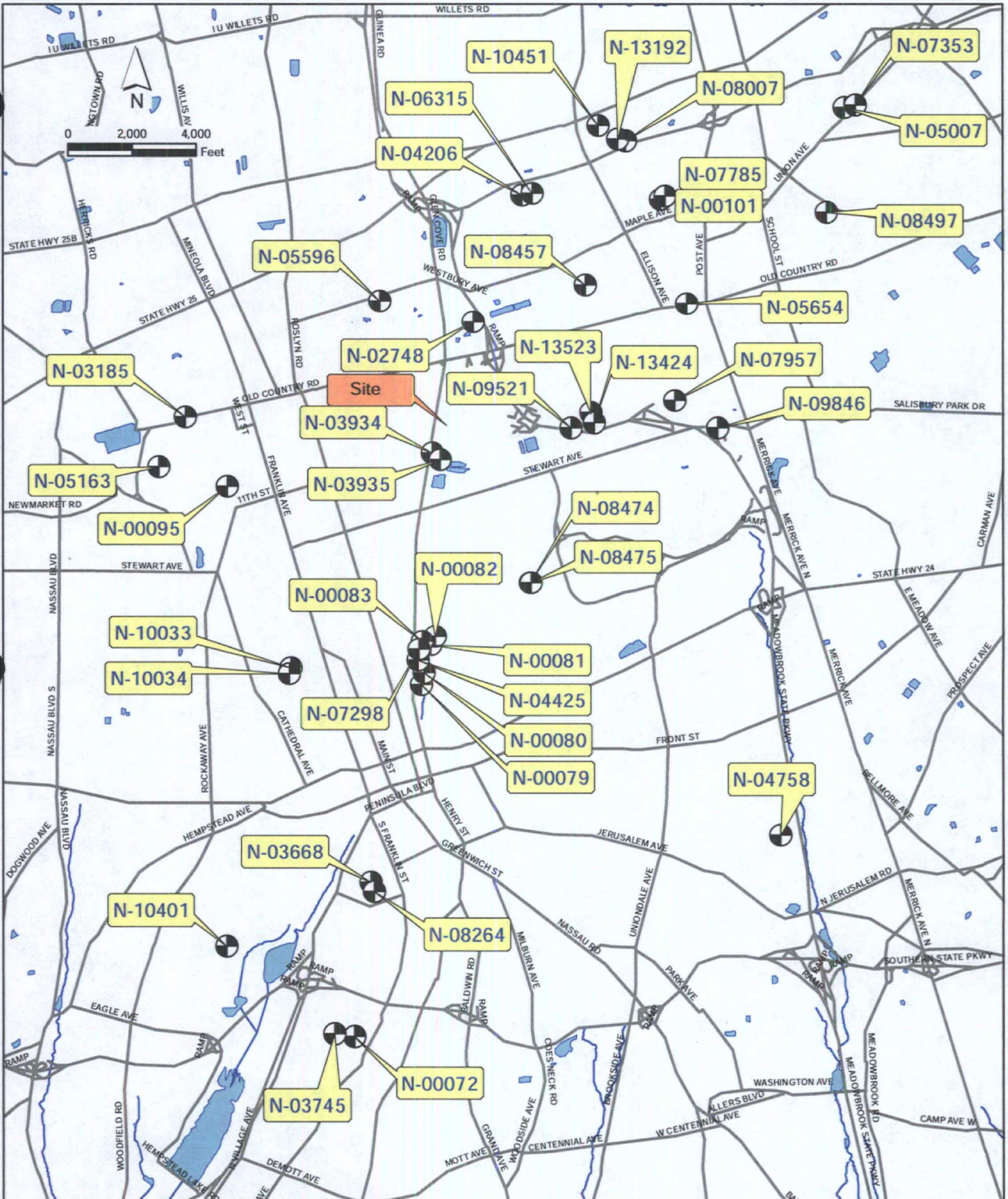


Figure 3
Old Roosevelt Field Groundwater Model
Water Level Time Histories - Selected Wells

CDM



Public Supply Well (NYSDEC ID)

Road

Figure 4

Community Public Supply Wells Surrounding the Old Roosevelt Field Site

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Public Supply Well
Multiport Well
Existing Well
Water Table (ft)

N

0 250 500 1,000 Feet

Figure 5a
Simulated Water Table Elevation - June 2004
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York

CDM

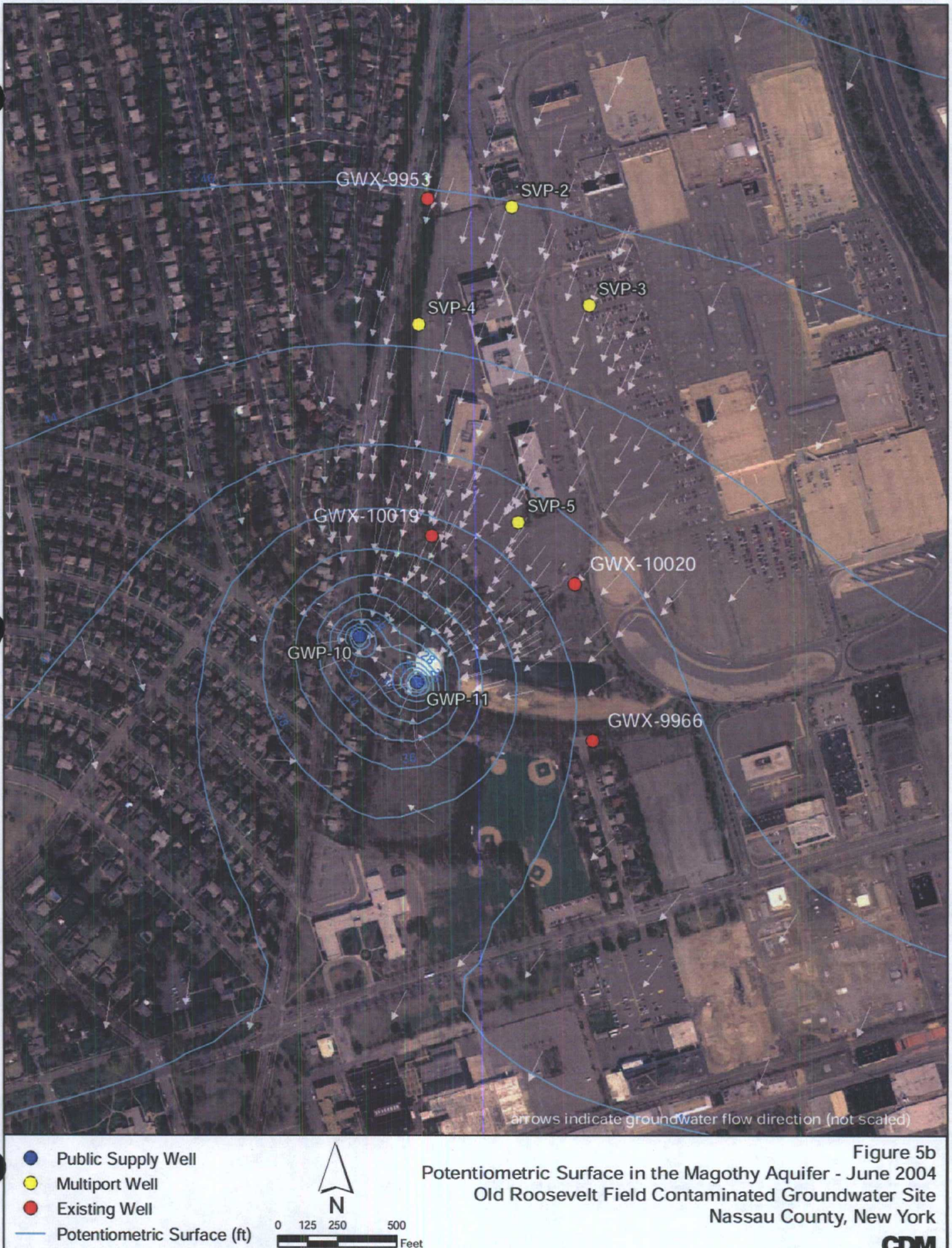


Figure 5b
Potentiometric Surface in the Magothy Aquifer - June 2004
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York
CDM

Magothy (also during June 2004) at approximately 300 feet below sea level. The significant impact of pumping from wells GWP-10 and 11 on the simulated flow field is evident on Figure 5b.

Transport Simulations

Following the development of the groundwater flow model, the model was used to evaluate a series of scenarios for the FS:

- Monitoring Alternative - Use the model to evaluate the downgradient migration of the TCE and PCE plumes and resulting attenuation from dilution and dispersion;
- Pump and Treat - Simulate a groundwater extraction well near SVP-04, which represents the "hot-spot" of the plume. Extracted groundwater would be treated and discharged to a nearby Nassau County recharge basin; and
- Contingency Plan - Use the model to determine a location, screen interval and pumping rate for a contingency extraction well(s) should the Garden City wells become inactive for an extended period of time.

Contaminant transport simulations were conducted using DYNTRACK, the companion solute transport code to DYNFLOW.

Transport simulations for the Old Roosevelt Field groundwater model assumed that the source was removed. Therefore, the existing plume, using the spatial extent as defined in the RI, was read into the model and a continuous source was not simulated. **It is important to note that the results presented in this memorandum are for the RI-defined plume only and do not account for additional sources or a source at the Old Roosevelt Field site. Any additional contamination outside the boundaries of the RI-defined Old Roosevelt Field plume was not simulated.**

Incorporation of the TCE and PCE Plumes into DYNTRACK

The estimated TCE and PCE plumes were incorporated into DYNTRACK by specifying concentrations at individual model nodes based on the 5 ppb and 100 ppb contours defined in the RI. As the clean-up level of the plume is 5 ppb (MCL), concentrations less than 5 ppb were not included in the defined plume (as illustrated in the RI). Model node spacing within the area of the plumes ranges from approximately 70 feet in the furthest upgradient portion of the plume down to approximately 10 feet near the supply wells. Plan views and cross-sections showing the initial extent of the estimated TCE and PCE plumes are shown on Figures 6 and 7, respectively.

A more detailed concentration distribution than presented in the RI was input in the model, as shown in Figures 6 and 7. The plumes in Figures 6 and 7 represent conceptual plumes and

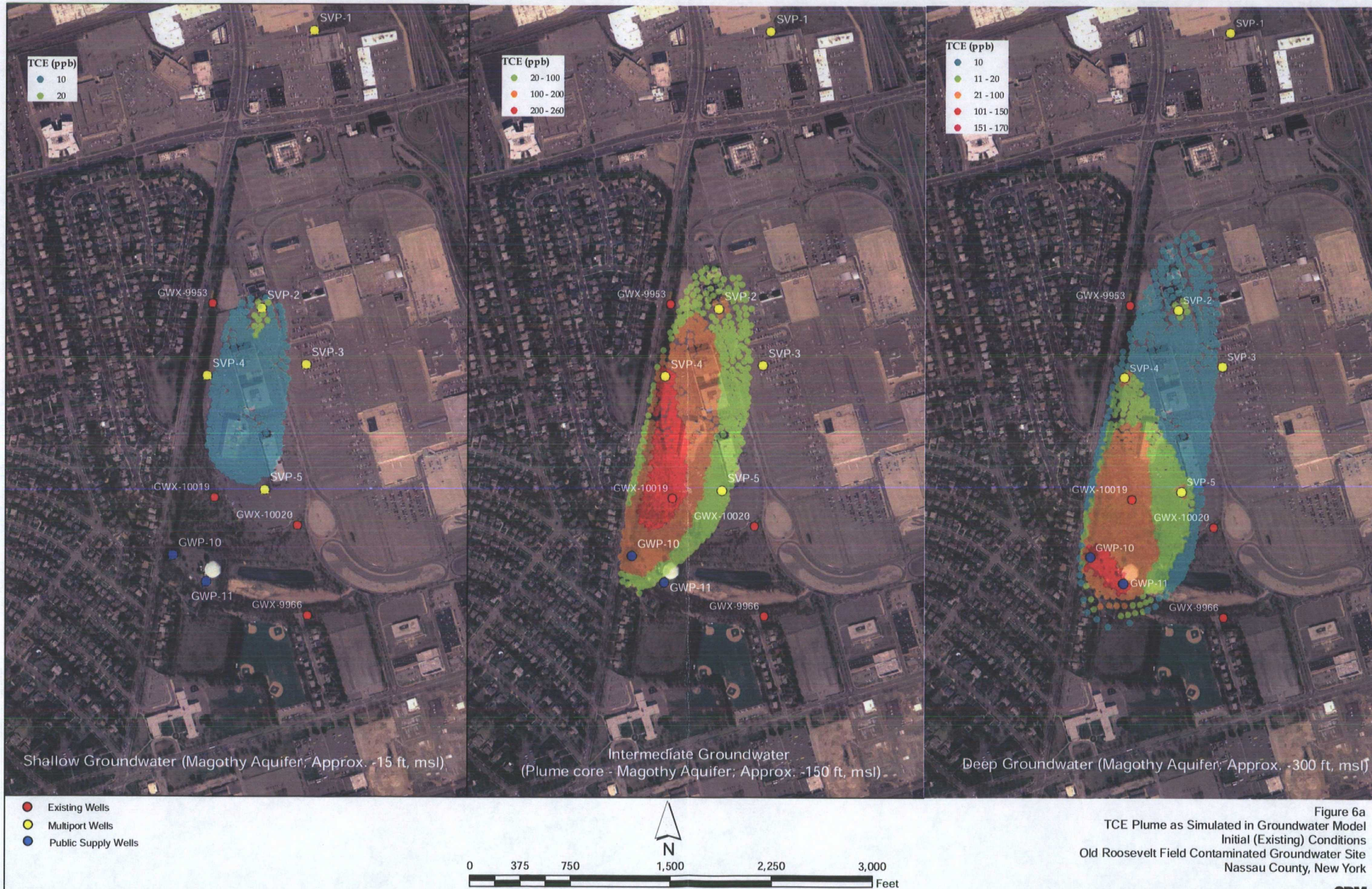
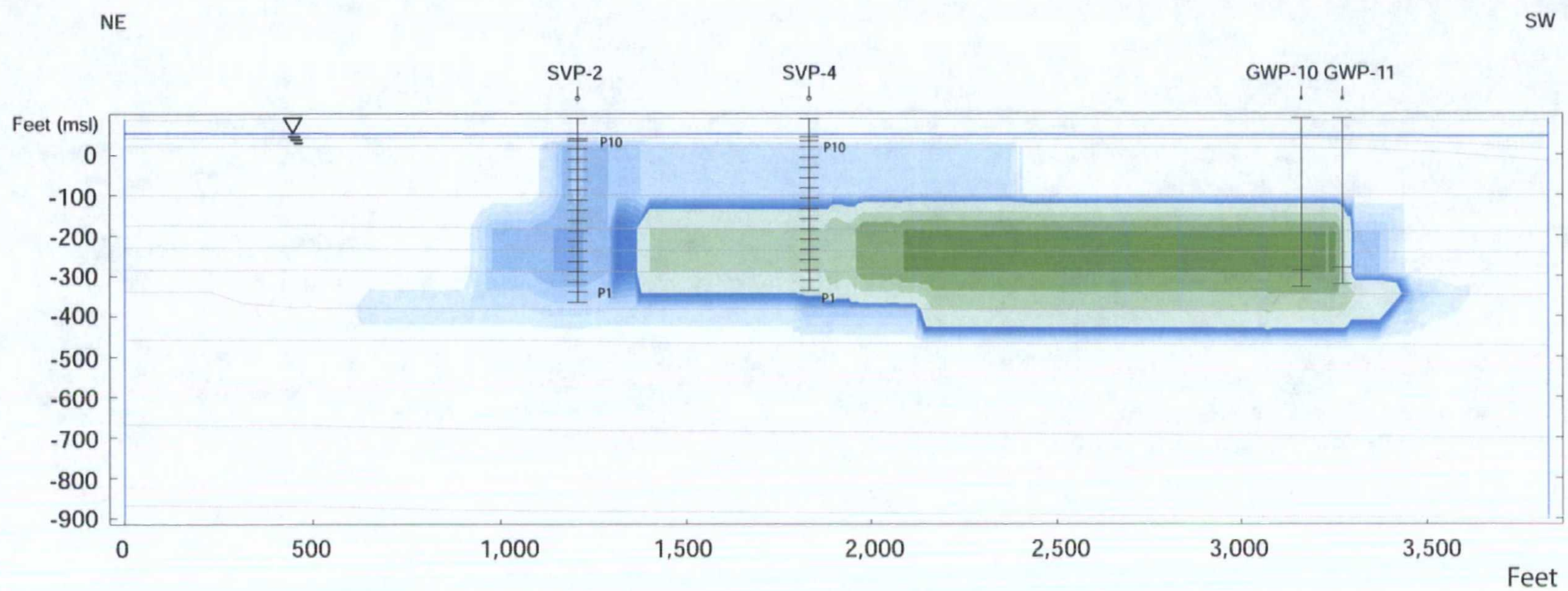
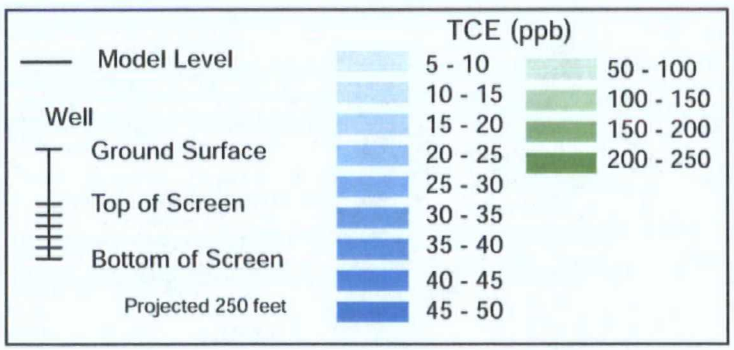


Figure 6a
TCE Plume as Simulated in Groundwater Model
Initial (Existing) Conditions
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York





CROSS SECTION

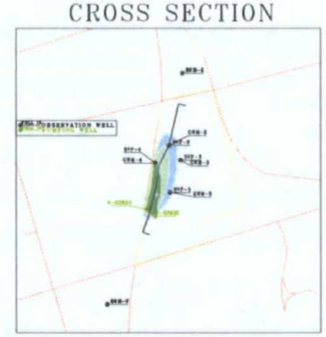


Figure 6b
Old Roosevelt Field Groundwater Model
Northeast-Southwest Cross Section
Simulated TCE Plume - Initial (Existing) Conditions

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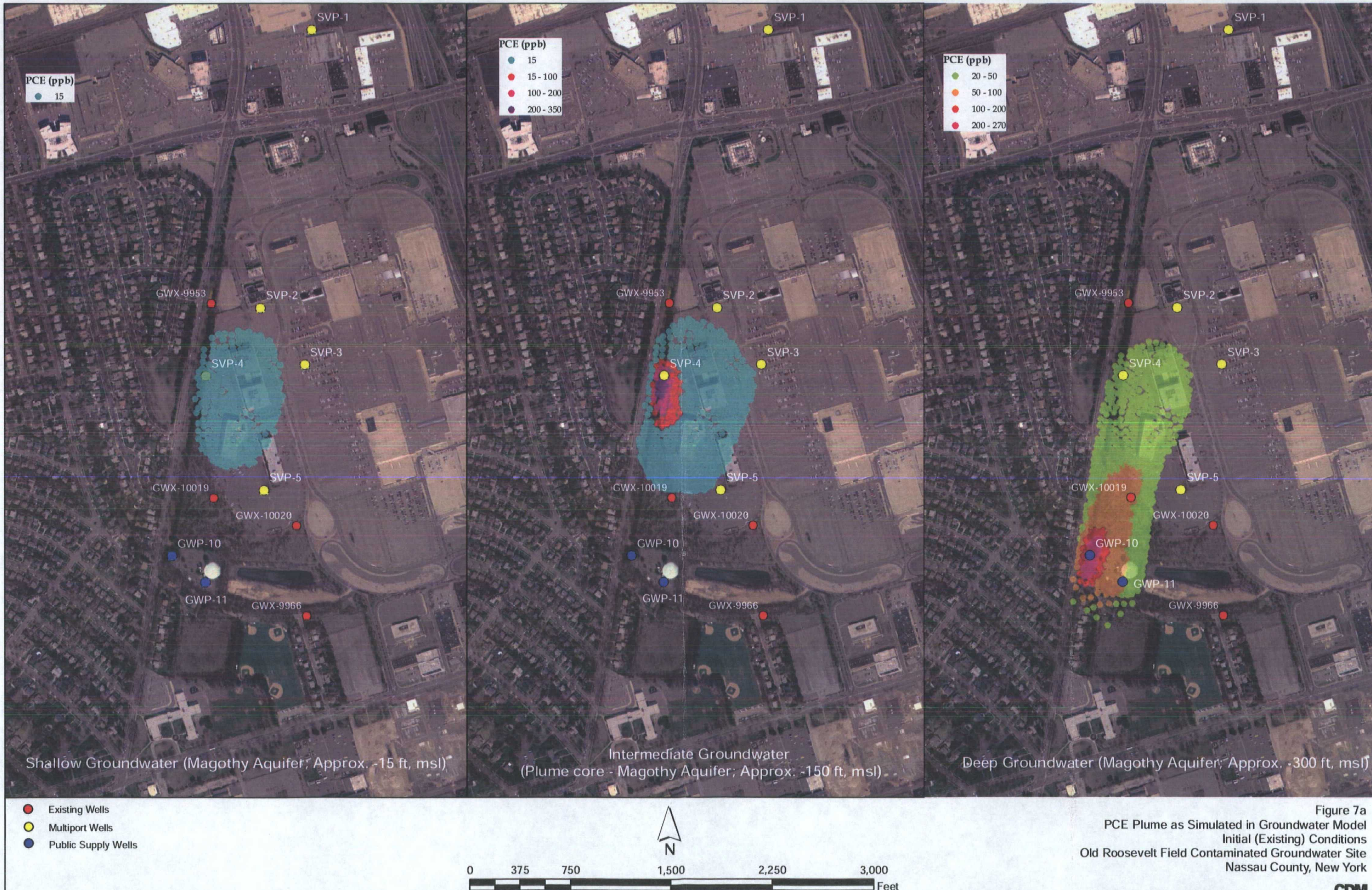


Figure 7a
PCE Plume as Simulated in Groundwater Model
Initial (Existing) Conditions
Old Roosevelt Field Contaminated Groundwater Site
Nassau County, New York

CDM

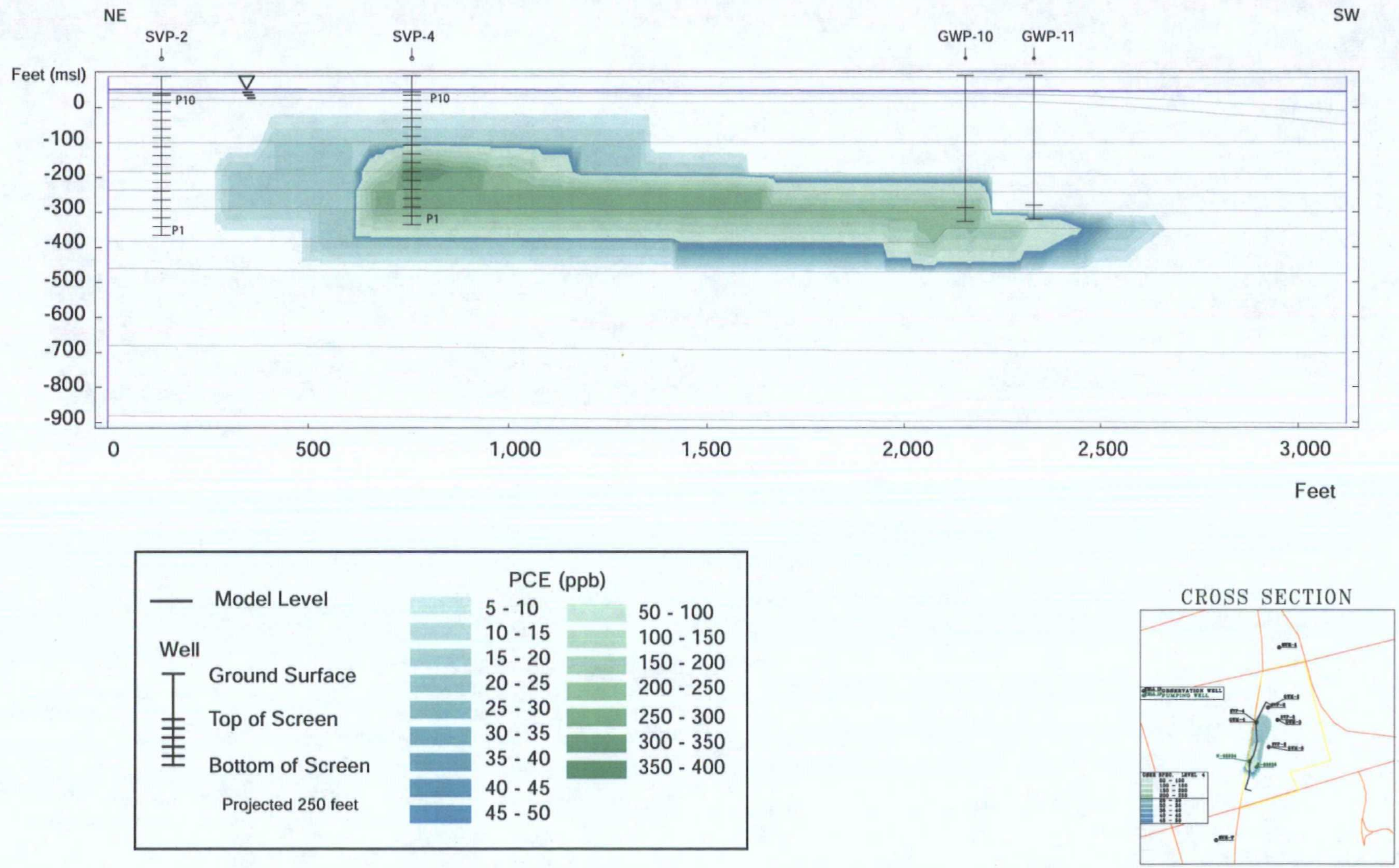


Figure 7b
Old Roosevelt Field Groundwater Model
Northeast-Southwest Cross Section
Simulated PCE Plume - Initial (Existing) Conditions
CDM

are likely conservative. The base of the plumes extends below the deepest well port in the multi-port wells (port 1). The plume in the model was extended at depth since the base of the plume was not identified in the RI. The surface of the plume also extends to approximately 20 feet above sea level, again representing a conservative approach. The results described in the sections below are based solely on the extent of the estimated plumes in Figures 6 and 7 and will likely change with modifications to the plume extent. Contaminants were not added to the upper glacial aquifer as water quality samples collected during the RI did not show concentrations exceeding 5 ppb.

Transport parameters for the plume and the Magothy aquifer are shown in Table 1. A range of effective porosities was simulated, as actual site specific data are not known. These effective porosities are within the range of those used in previous modeling in Nassau County. Values for horizontal and transverse dispersivity and vertical dispersion are typical values that have been used in various groundwater models on Long Island.

Table 1
Transport Parameters for TCE, PCE, and the Magothy Aquifer

Compound	Retardation Factor (dimensionless)[1]	Effective Porosity (dimensionless)	Longitudinal / Transverse Dispersivity (ft)	Vertical Dispersion Anisotropy Ratio (dimensionless)
TCE	1.3	0.10 – 0.20	30 / 3	0.1
PCE	1.8	0.10 – 0.20	30 / 3	0.1

1. Retardation factors are from the Remedial Investigation Report

A vertical dispersion anisotropy ratio of 0.1 was specified to suppress the computed vertical dispersion with respect to horizontal dispersion. It should be noted that the values used to simulate dispersion have not been calibrated to this specific plume per se, and therefore uncertainty is increased. These values, however, have been shown to be effective in other contaminant transport simulations on Long Island. As a conservative approach, degradation of PCE and TCE was not simulated.

Monitoring Alternative

A contaminant transport simulation was conducted to evaluate the downgradient migration and attenuation (through dispersion and dilution) of the TCE and PCE plumes, as defined in the RI. Monthly data from 2001 through 2005 were obtained from Nassau County Department of Public Works and were used to represent a recent 5-year period. Since pumpage varies considerably throughout the year (highest pumpage during summer months), using an average rate for this analysis would not be sufficiently representative of actual conditions. To account for periods longer than five years, the 2001-2005 monthly pumpage data were repeated. Therefore, following December 2005 pumping rates, January 2001 pumping rates were used and the simulation continued in 5-year cycles. Pumpage data from 2001-2005 from

Garden City wells 10 and 11 is shown on Figure 8. Monthly pumpage between 2001 through 2005 were also simulated at surrounding supply wells. As mentioned above, sensitivity simulations were conducted on effective porosity, using values of 0.10, 0.15, and 0.20 for the Magothy aquifer.

Plan views and cross sections of the simulated TCE and PCE plume distributions after various time periods are shown on Figures 9 and 10, respectively (for effective porosity of 0.15). Plan views (Figures 9a and 10a) show maximum simulated concentrations at all depths. Model results suggest that if the wells are continuously pumped at rates equivalent to monthly average rates between 2001-2005 and cycled, concentrations greater than or equal to 5 ppb are captured by the wells. The number of years required to achieve concentrations less than 5 ppb (i.e., "clean-up time") are shown in Table 2 for all three simulated values of effective porosity. PCE is the controlling plume, in which clean up times range between 30 and 61 years.

As shown on Figures 9 and 10, a portion of the plume that is greater than 5 ppb migrates downgradient of the Garden City wells. However, this portion of the plume remains under the influence of the supply wells, at the fringe of the capture zone, and concentrations slowly decrease through dispersion. The time required to clean up this portion of the plume is significant and clean-up times would be greatly decreased if this portion does not bypass the Garden City wells. As mentioned above, a conservative approach was utilized for the plume extent. In addition, should Garden City consistently pump wells 10 and 11 at rates higher than rates specified in 2001-2005, this portion of the plume may be captured. Additional model simulations are required at specified pumping rates for verification.

The number of years to reach concentrations below 5 ppb and 1 ppb from supply wells 10 and 11 (Table 2) include dilution from pumping since the capture zone of the supply wells extends beyond the plume extent. Therefore, although groundwater concentrations within the plume immediately upgradient of the supply wells may exceed 5 ppb, during normal operation the supply wells withdraw a large volume of "clean" water from areas outside the plume extent which dilute the observed concentrations of PCE/TCE in the well. It is important to note that should additional sources or plumes outside of the simulated Roosevelt Field plume exist within the capture zone of the wells, the times listed in Table 2 may increase significantly.

It is important to note that the clean-up times listed on Table 2 and the plume distribution in Figures 9 and 10 do not consider possible "tailing" effects associated with non-instantaneous equilibrium adsorption/desorption, e.g., portions of the plume that may diffuse into the aquifer matrix and slowly dissolve into the surrounding groundwater. Also, as mentioned above, only the TCE and PCE plumes, as represented in the RI, are considered. The model assumes that there is not a continuous source and no additional sources are simulated.

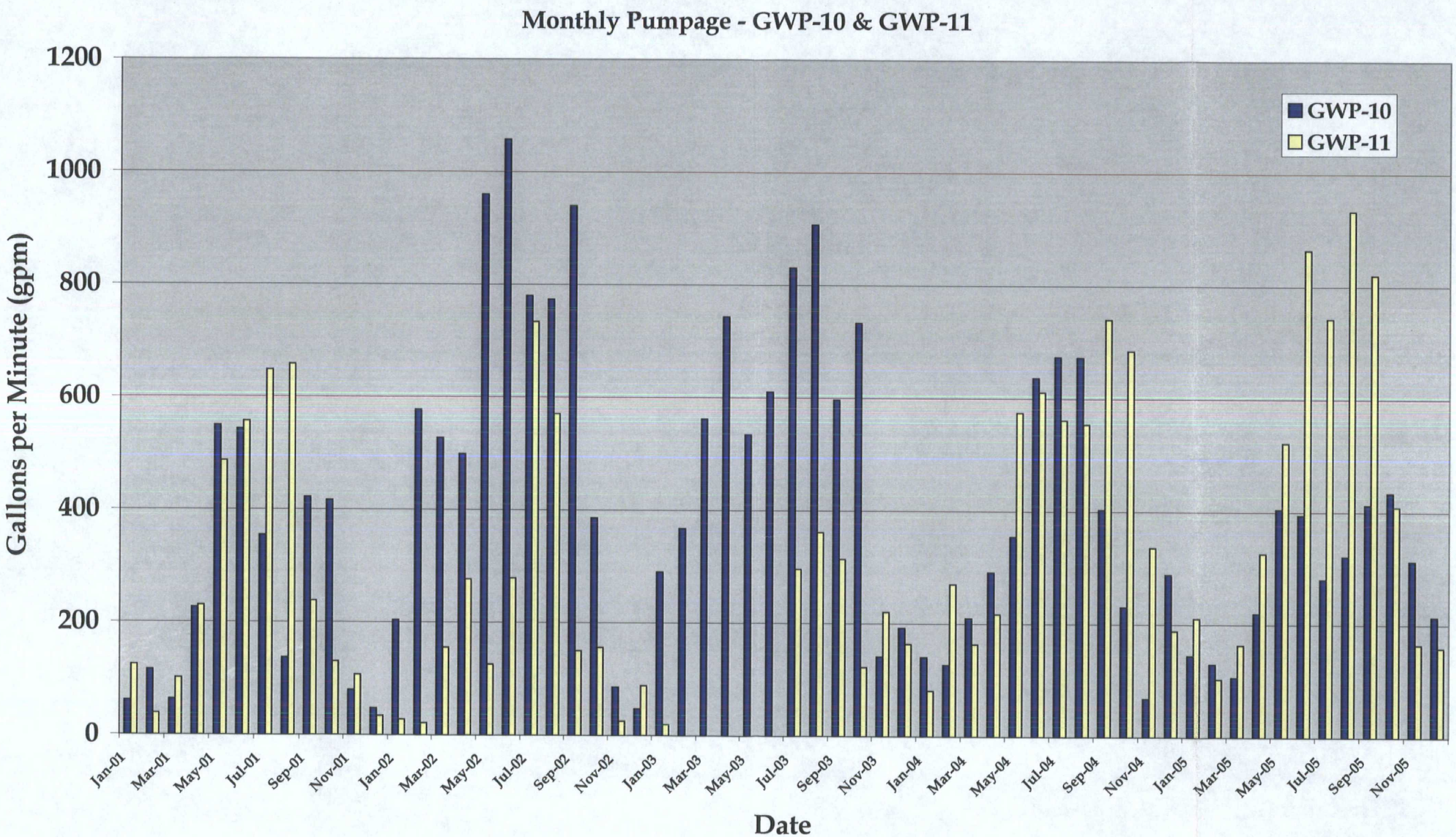


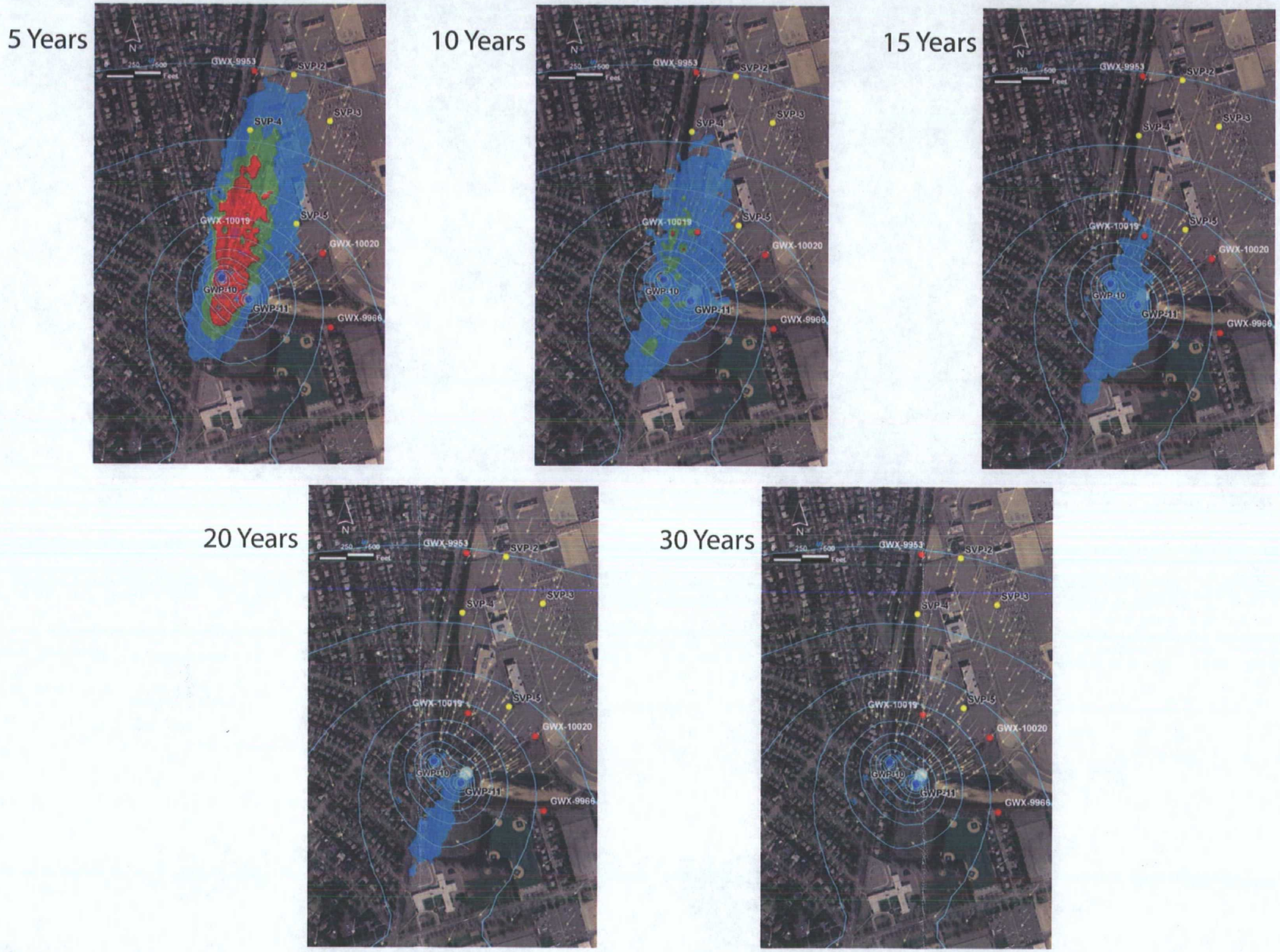
Figure 8
Old Roosevelt Field Groundwater Model
Simulated Pumping at Garden City Wells 10 and 11

TCE (ppb)

- 5 - 50
- 50 - 100
- 100 - 250
- > 250

- Public Supply Well
- Multiport Well
- Existing Well

- Potentiometric Surface (ft, msl)
- Groundwater Flow Direction (not scaled)



Note: Groundwater flow direction and potentiometric surface are for the Magothy aquifer, approximately 275 feet below mean sea level. June 2004 pumping conditions (total of 1,247 gpm). Maximum simulated concentrations shown.

Figure 9a
Old Roosevelt Field Groundwater Model
Simulated TCE Plume after 5, 10, 15, 20, and 30 Years of Pumping GWP-10 & GWP-11
Monthly Pumping Rates - 2001 through 2005

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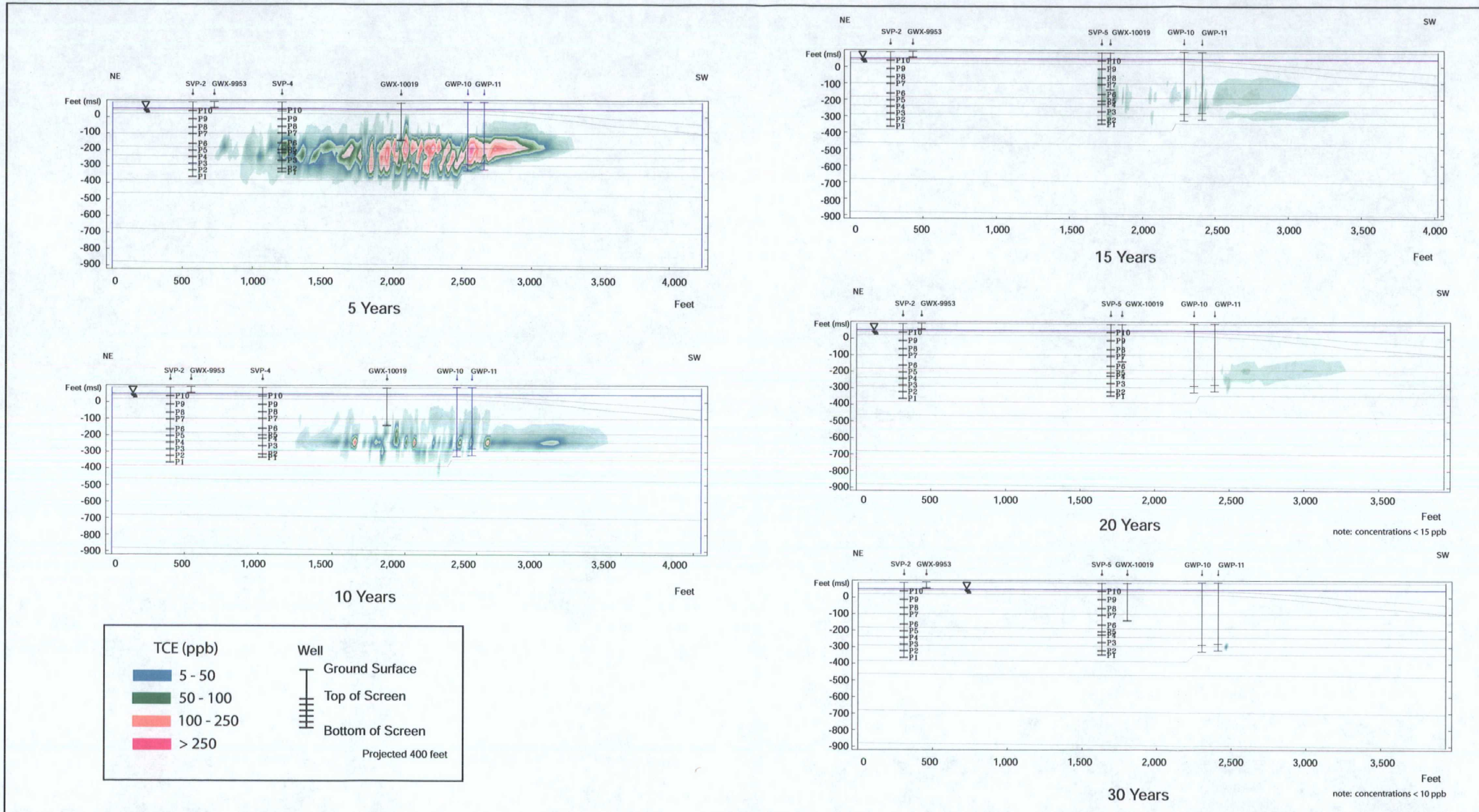
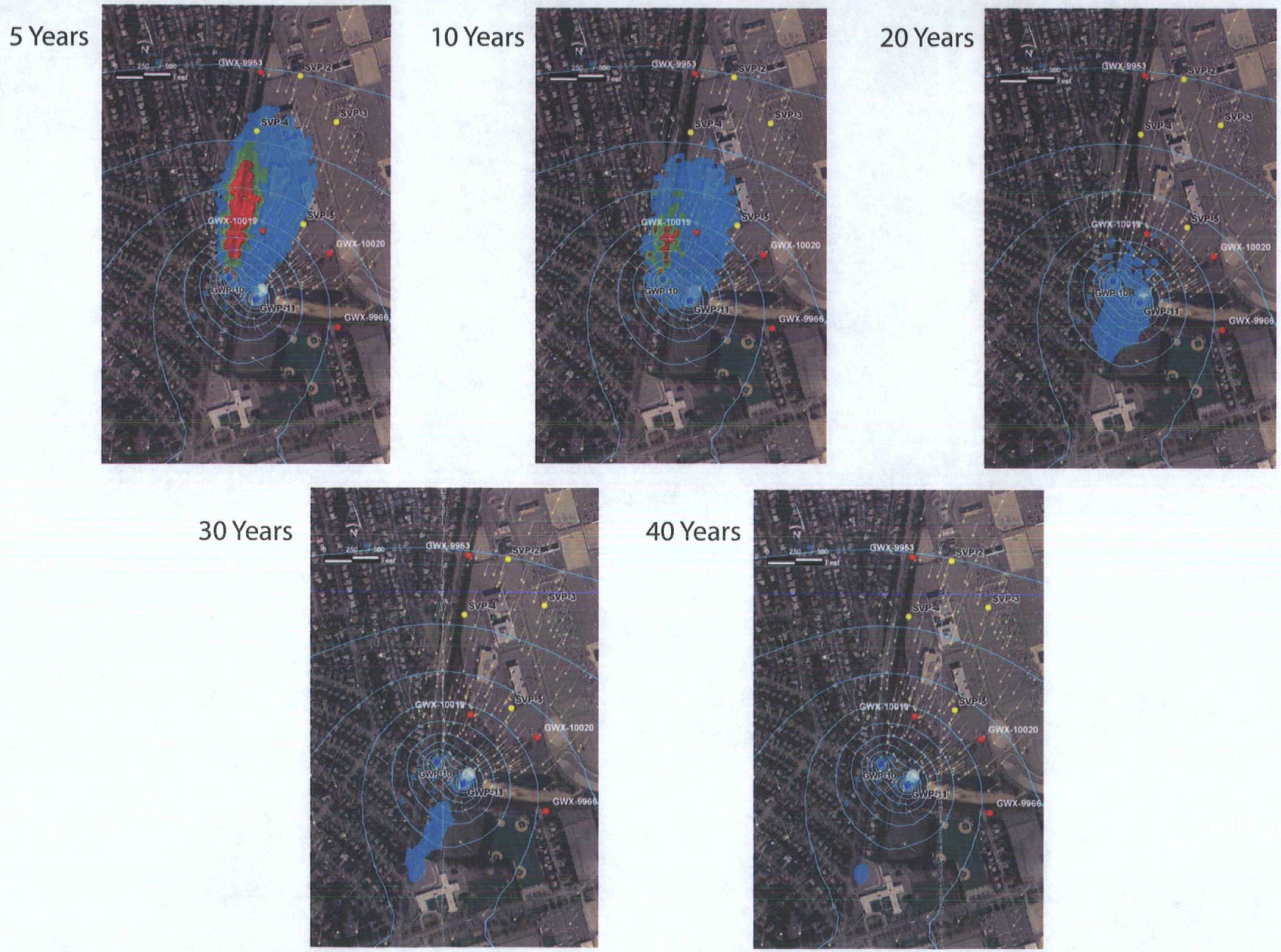


Figure 9b
Old Roosevelt Field Groundwater Model
Simulated TCE Plume after 5, 10, 15, 20, and 30 Years of Pumping GWP-10 & GWP-11
Monthly Pumping Rates - 2001 through 2005

CDM



PCE (ppb)

- 5 - 50
- 50 - 100
- 100 - 250
- > 250

- Public Supply Well
- Multiport Well
- Existing Well

- Potentiometric Surface (ft, msl)
- Groundwater Flow Direction (not scaled)

Note: Groundwater flow direction and potentiometric surface are for the Magothy aquifer, approximately 275 feet below mean sea level. June 2004 pumping conditions (total of 1,247 gpm). Maximum simulated concentrations shown.

Figure 10a
Old Roosevelt Field Groundwater Model
Simulated PCE Plume after 5, 10, 20, 30, and 40 Years of Pumping GWP-10 & GWP-11
Monthly Pumping Rates - 2001 through 2005

CDM

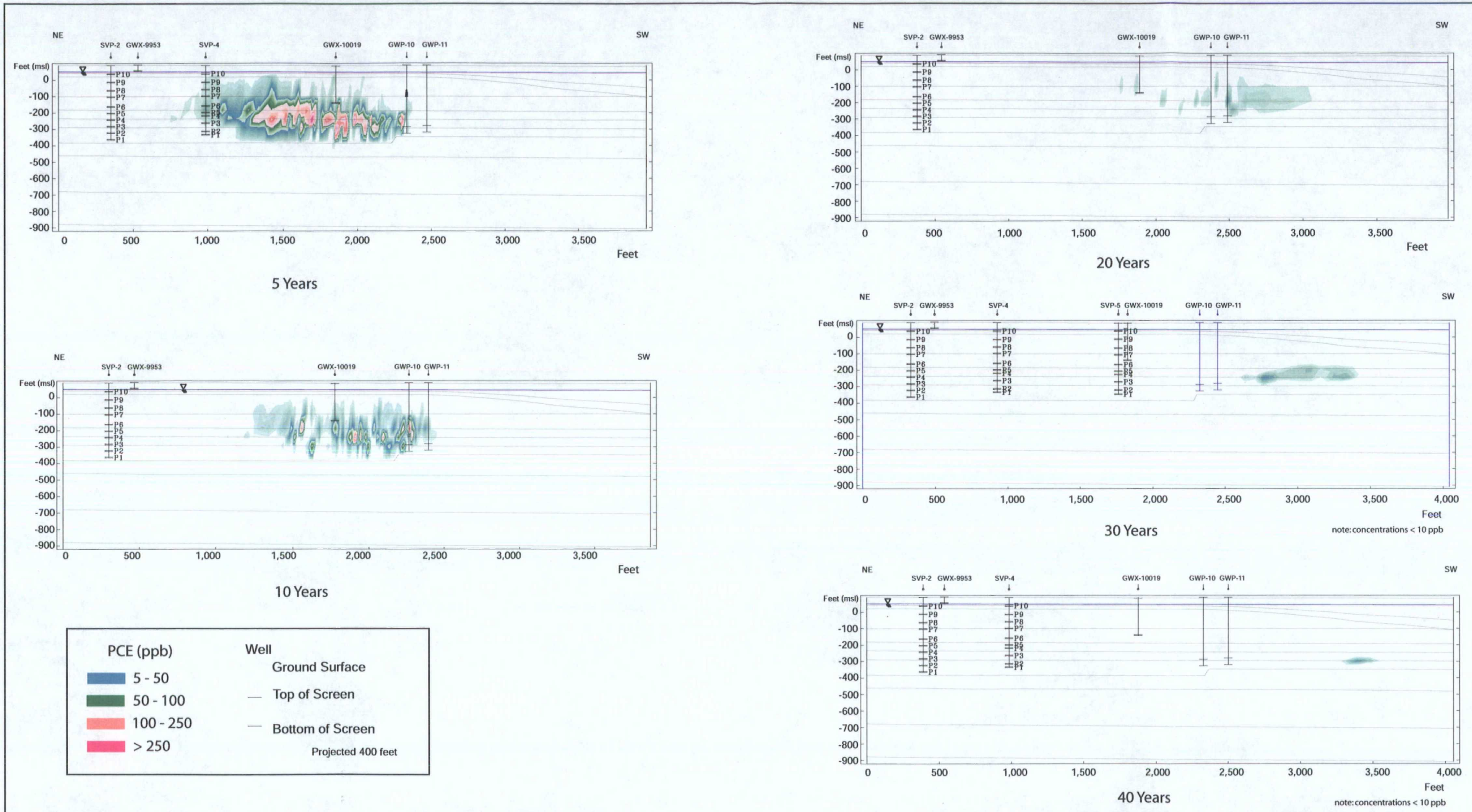


Figure 10b

Old Roosevelt Field Groundwater Model

Simulated PCE Plume after 5, 10, 20, 30, and 40 Years of Pumping GWP-10 & GWP-11

Monthly Pumping Rates - 2001 through 2005

CDM

Table 2
Simulated Clean-Up Time (to below 5 ppb) for TCE and PCE Plumes

Effective Porosity	Plume Clean-up Time (years)		# of Years for < 5 ppb at Supply Wells 10 & 11		# of Years for < 1 ppb at Supply Wells 10 & 11	
	TCE	PCE	TCE	PCE	TCE	PCE
0.10	24	30	6	7	9	9
0.15	29	46	8	9	13	15
0.20	50	61	12	12	18	18

The initial concentrations of the TCE and PCE plumes at the supply wells are assumed to represent concentrations in the surrounding groundwater rather than within the wells during normal operation. Therefore, it is assumed that samples at the supply wells were collected when the wells were not operating at normal capacity but rather at a very low pumping rate to collect samples. If TCE and PCE concentrations from the supply wells (from Table 1-1 in the RI) were collected during full operation of the supply wells (i.e., at the influent of the air strippers), the initial concentrations of the TCE and PCE plumes within ambient groundwater must be increased to reflect the increased concentrations in the wells. Increased concentrations in the initial plume may result in longer clean-up times required to reduce the plume to concentrations below 5 ppb. Longer time periods may also be required to reduce concentrations in the wells below 5 and 1 ppb.

Although Figures 9 and 10 suggest that the portion of the plume greater than 5 ppb is captured by the Garden City supply wells, simulation results indicate that portions of the plume at lower concentrations bypass the two supply wells and migrate downgradient toward Hempstead Village wells 1 (N-04425), 4 (N-00081), 5 (N-00082), and 8 (N-07298; Figure 11). Since the clean-up level for the Old Roosevelt Field plume is 5 ppb, this portion of the plume is not shown on Figures 9 and 10. Simulated concentrations at the Hempstead Village supply wells are 2 ppb or less. Should actual starting plume concentrations exceed those as specified in the model (Figures 6 and 7), it is possible that higher concentrations may impact Hempstead supply wells. Additional design phase model simulations at projected pumping rates (as specified by Garden City and Hempstead Village) should be conducted to further assess the likelihood of plume migration downgradient toward the Hempstead wells.

It should be noted that a portion of the plume is captured by Hempstead supply wells despite the Garden City supply wells being simulated in continuous operation. Should the Garden City supply wells become non-operational for an extended period of time, or if pumping rates decrease significantly, it is possible that a more significant portion of the Old Roosevelt Field plume may impact the downgradient Hempstead wellfield.

Figure 11
Old Roosevelt Field Groundwater Model
Hempstead Village Wellfield Downgradient of
Garden City Supply Wells 10 & 11

CDM

Pump and Treat Alternative

The second alternative evaluated with the groundwater model involved groundwater extraction and ex-situ treatment (pump and treat) in which an extraction well was simulated upgradient, within the vicinity of SVP-04. This location represents the "hot spot" of the plume, or the area with the highest observed concentrations of TCE and PCE. Conceptually, an upgradient extraction well would decrease the clean-up time by removing portions of the plume upgradient and within its capture zone and allow for a reduction of mass to be treated at GWP-10 and 11.

Various simulations were conducted to determine what pumping rate and screen interval would be most suitable for remediating the Old Roosevelt Field plume while the Garden City supply wells were in operation. As with the monitoring alternative, monthly pumpage data between 2001-2005 were simulated for GWP-10 and 11 and surrounding wellfields (Figure 4). The upgradient extraction well must be sited far enough away from GWP-10 and 11 and pump at a rate that will not significantly impact head in the wells. For the purposes of this simulation, water pumped from the upgradient extraction well is treated and discharged to the Nassau County recharge basin along Stewart Avenue (Nassau County basin #124), immediately south of the Garden City wellfield.

A single extraction well was simulated pumping continuously at 150 gpm, having a screen interval between 175 to 275 feet below mean sea level. The screen interval was simulated to be set within the highest concentration at SVP-04. The simulated well location and recharge basin are shown on Figure 12.

The upgradient extraction well was shut down after 10 years of continuous pumping because much of the upgradient portion (upgradient of SVP-04E) of the plume was "cleaned-up" (below 5 ppb) within 10 years. Pumping from both the upgradient extraction well and GWP-10 and 11 causes a zone of low flow to develop between the extraction well and GWP-10/11. Although upgradient extraction removes the portion of the plume near and upgradient of SVP-04E, it slows the migration of the downgradient portion of the plume flowing toward GWP-10 and 11 and forces some of the plume back upgradient. This phenomenon is illustrated on Figure 13.

The overall "clean-up" times and the number of years required to reduce TCE and PCE concentrations below 5 ppb and 1 ppb at GWP-10 and 11 are shown in Table 3. The simulated plume extent is shown for various time periods on Figure 13a. As described above for Table 2, the time periods specified in Table 3 are based on the simulated TCE/PCE plume only and additional sources are not included. Clean-up times may be extended should the initial TCE/PCE plume, as incorporated into the model, be modified.

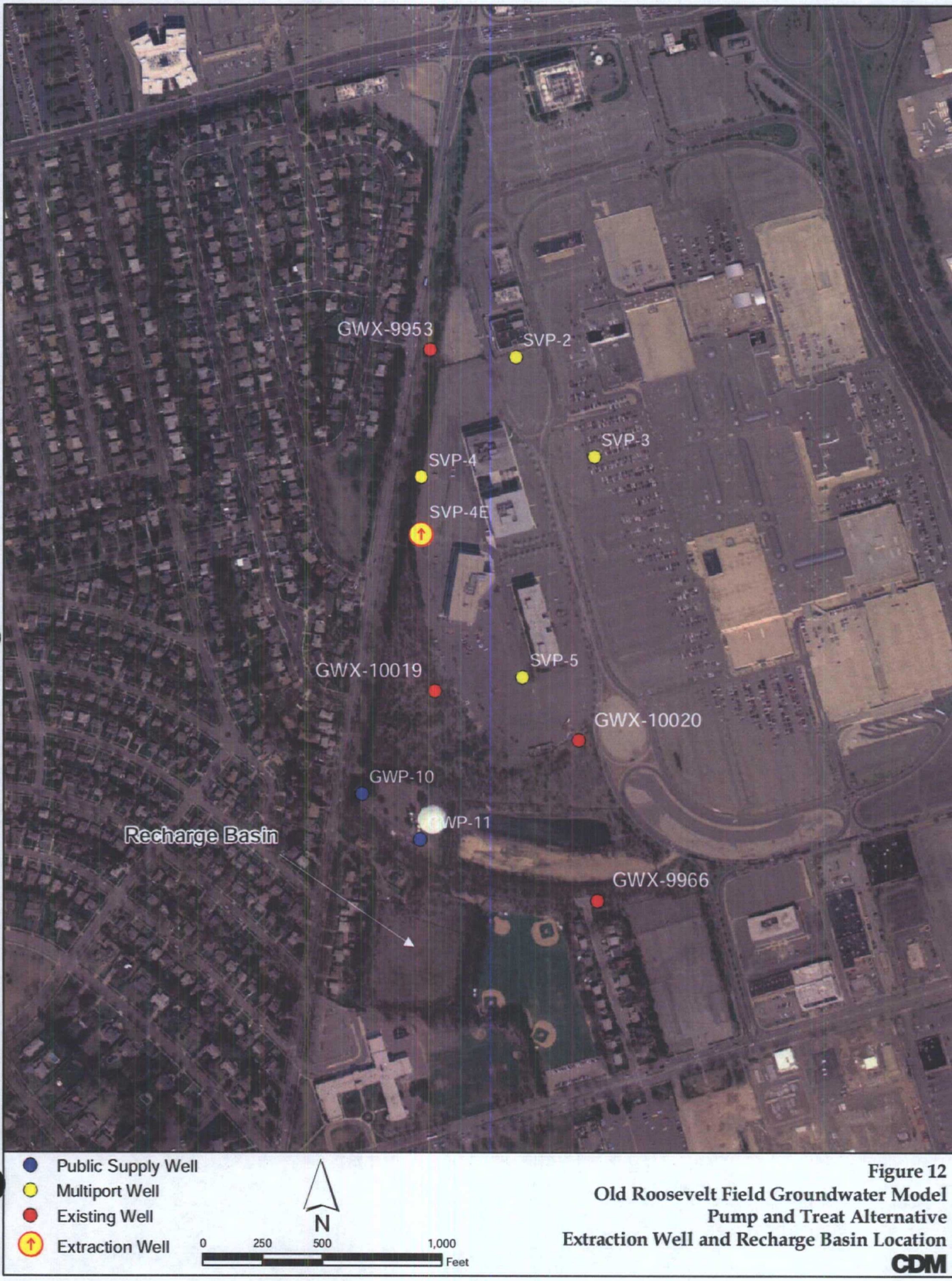


Figure 12
Old Roosevelt Field Groundwater Model
Pump and Treat Alternative
Extraction Well and Recharge Basin Location

CDM

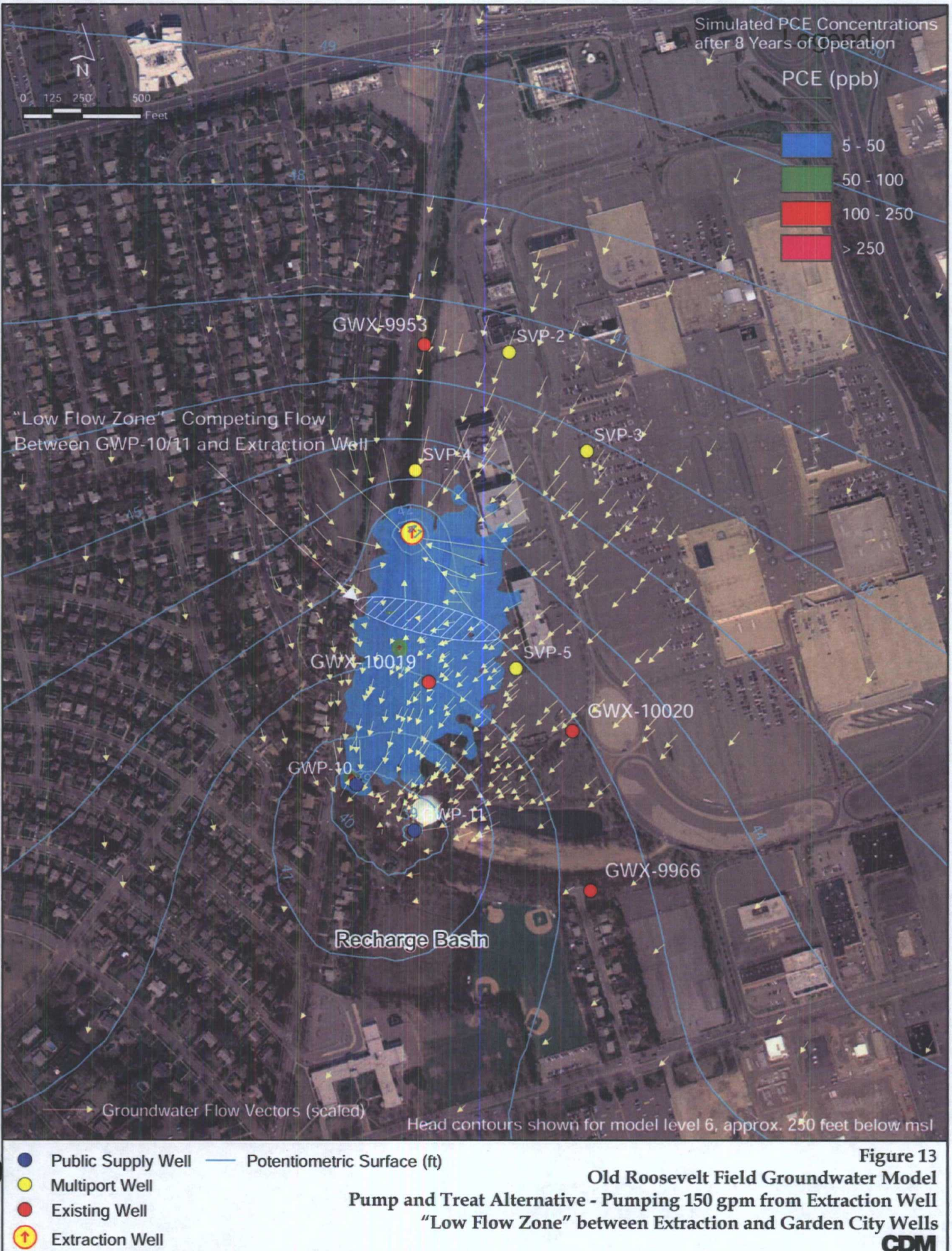


Figure 13
Old Roosevelt Field Groundwater Model
Pump and Treat Alternative - Pumping 150 gpm from Extraction Well
"Low Flow Zone" between Extraction and Garden City Wells

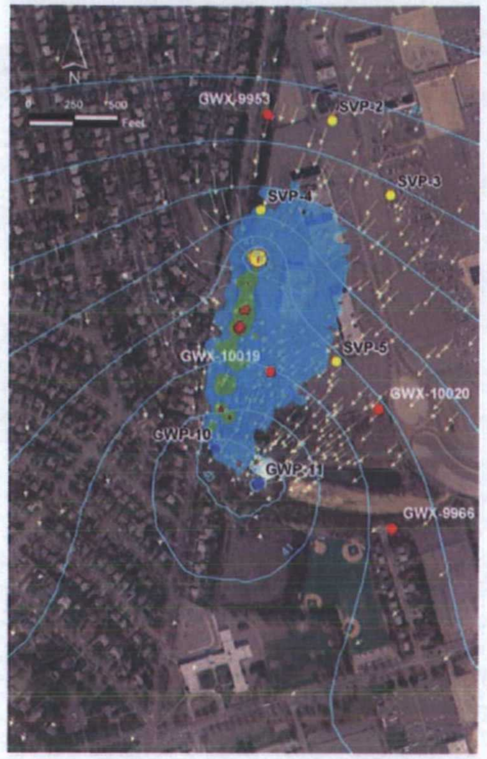
CDM

PCE (ppb)

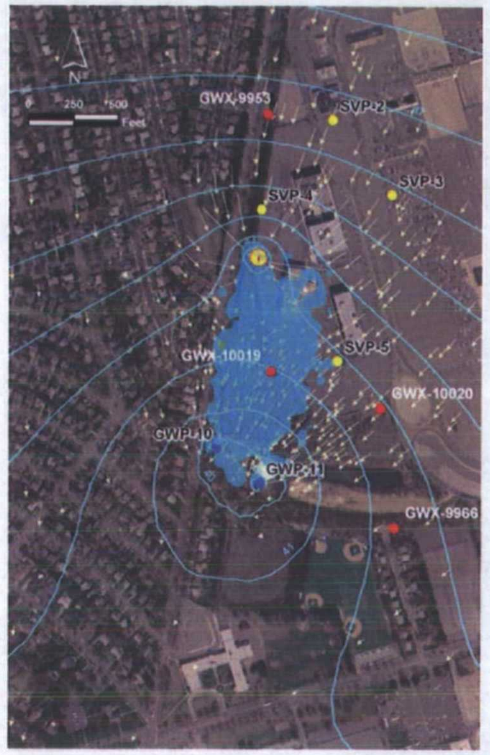
- 5 - 50
- 50 - 100
- 100 - 250
- > 250

- Public Supply Well
- Multiport Well
- Existing Well
- Extraction Well
- Potentiometric Surface (ft, msl)
- Groundwater Flow Direction (scaled)

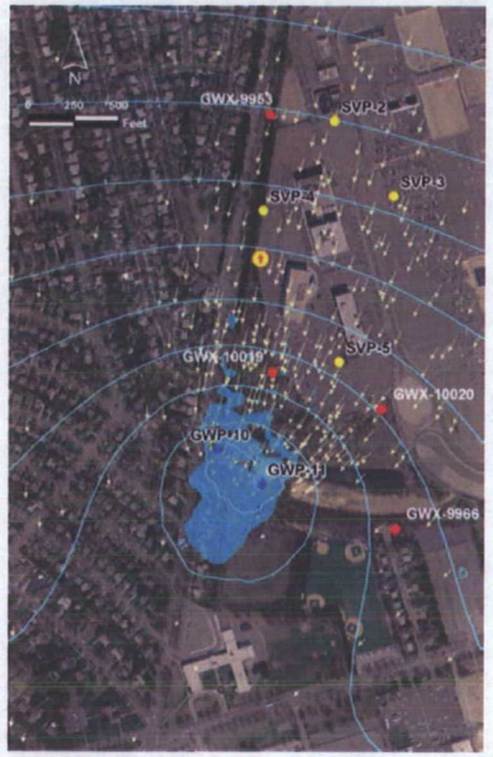
5 Years



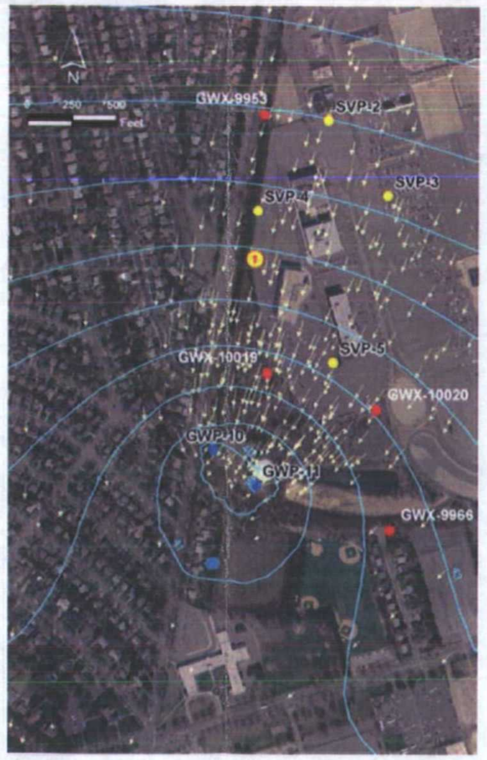
10 Years



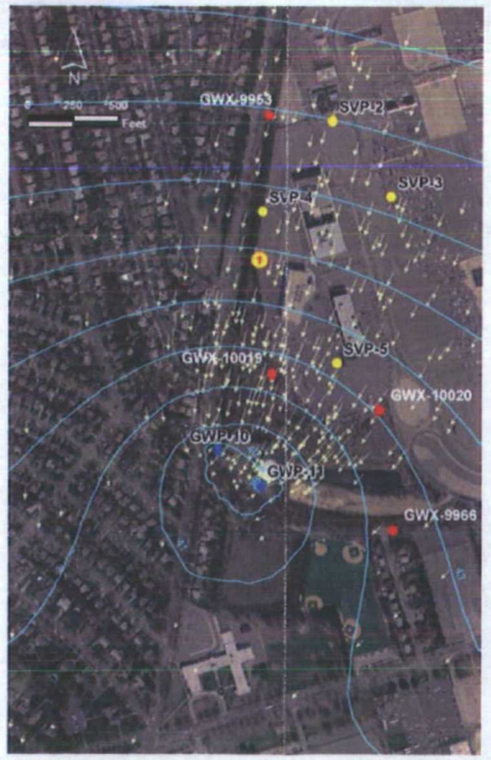
20 Years



30 Years



40 Years



Note: Groundwater flow direction and potentiometric surface are for the Magothy aquifer, approximately 250 feet below mean sea level. June 2004 pumping conditions (total of 1,247 gpm). Maximum simulated concentrations shown.

Figure 13a
Old Roosevelt Field Groundwater Model
Simulated PCE Plume after 5, 10, 20, 30, and 40 Years Following 10 Years of Pump & Treat (150 gpm)
GWP-10 & 11 - Monthly Pumping Rates - 2001 through 2005

CDM

Table 3
Simulated Clean-Up Times for Pump and Treat Alternative
Pumping 150 gpm for 10 years near SVP-04

Effective Porosity	Plume Clean-up Time (years)		# of Years for < 5 ppb at Supply Wells 10 & 11		# of Years for < 1 ppb at Supply Wells 10 & 11	
	TCE	PCE	TCE	PCE	TCE	PCE
0.10	14	25	3	4	7	7
0.15	28	35	5	5	9	10
0.20	38	51	7	7	14	15

As described above for the monitoring alternative, the number of years to reach concentrations below 5 ppb and 1 ppb in supply wells 10 and 11 include dilution from pumping since the capture zone of the supply wells extends beyond the plume extent. Should additional sources or plumes outside of the simulated Roosevelt Field plume exist within the capture zone of the wells, the number of years for the wells (pumped discharge) to have less than 5 ppb and 1 ppb may increase significantly.

As mentioned above, water pumped from the upgradient extraction well was discharged to the downgradient recharge basin (basin 124; extracted water will be treated prior to discharge to the recharge basin). Water was returned uniformly over the recharge basin at the water table. The discharge of 150 gpm of water to the recharge basin results in a mounding effect in the model. Water table rises approximately 0.9 foot from discharging the treated water. It is important to note that it is assumed that the recharge basin has a sufficient infiltration capacity to accommodate an additional 150 gpm (over and above normal storm water discharge). Infiltration tests should be conducted on the recharge basin for verification.

Pumping 150 gpm from the extraction well at the simulated location with recharge at the downgradient recharge basin has a limited impact to GWP-10 and 11. Simulations indicate that heads at the supply wells are reduced by approximately 0.2 foot.

Contingency Plan
In the event that GWP-10 and 11 become inactive or go out of service for an extended period of time, a contingency plan was evaluated using the groundwater model. Simulations were conducted to site an extraction well and determine the approximate pumping rate necessary to capture the plume. Model simulations suggest that a single extraction well located immediately upgradient of GWP-10 and 11 having a screen interval of 285 to 325 feet below mean sea level is sufficient to capture the plume if pumped continuously at 500 gpm. It may not be possible for the recharge basin to handle 500 gpm from the contingency well, so upgradient injection may be required. The simulated location of the contingency extraction well and potential locations for injection wells are shown on Figure 14.

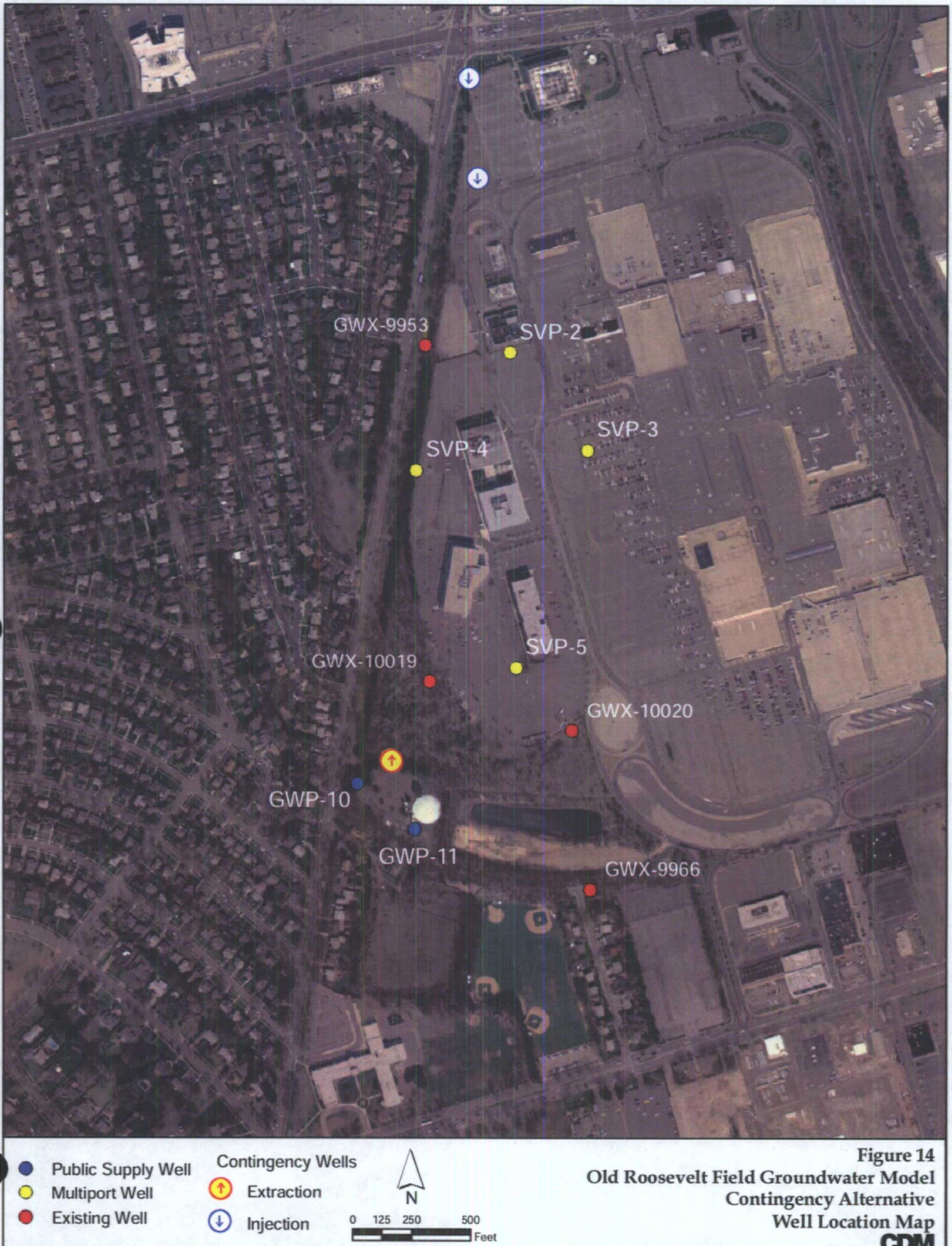


Figure 14
Old Roosevelt Field Groundwater Model
Contingency Alternative
Well Location Map
CDM

The contingency well simulation assumed that the recharge basin could receive 200 gpm without flooding. The remaining 300 gpm was injected into the two injection wells each having a 100 foot screen interval of 200 to 300 feet below mean sea level (150 gpm in each well). The water table was simulated to rise up to 2.4 feet beneath the recharge basin. Head increase in the Magothy from injecting 300 gpm at the injection wells is simulated to be approximately 11 feet. Should the recharge basin be capable of receiving 500 gpm (therefore no upgradient injection), the water table rise at the recharge basin is simulated to exceed 3.9 feet. All extracted water is assumed to be treated prior to injection or discharge to the recharge basin.

As with the monitoring and pump and treat alternative, this simulation was conducted using the plume as defined in the RI. Should the Old Roosevelt Field plume be modified or additional plumes outside of the simulated Roosevelt Field plume exist within the capture zone of the contingency well, the required extraction rate and well site (including screen interval) may change.

Conclusions and Recommendations

Three scenarios were evaluated using the groundwater model developed for the Old Roosevelt Field groundwater model. From the simulations described in this memo, the following conclusions can be made:

- Results from the monitoring alternative simulation indicate that most of the TCE/PCE plume is captured by the two Garden City wells, GWP-10 and GWP-11, although a small portion of the plume (below 5 ppb) may reach the downgradient Hempstead Village wellfield.

- Additional model simulations should be run using projected flow rates, as specified by Garden City and Hempstead Village (as opposed to 2001-2005 rates).

- The entire water quality data set collected by Garden City (air stripper influent, well-head concentrations under pumping and non-pumping conditions (if applicable) should be evaluated to determine if the starting PCE/TCE plume requires modification.

- Simulating upgradient extraction of 150 gpm for 10 years near SVP-04, the overall clean-up time of the PCE plume decreased by approximately 11 years.

- Infiltration tests should be conducted on the downgradient recharge basin (Nassau County basin 124) to determine the maximum flow rate that the basin can receive (above and beyond storm water runoff).

- A multiport monitoring well should be installed in the Magothy aquifer downgradient of GWP-10 and GWP-11 (and upgradient of the Hempstead wells) to verify the extent of the TCE/PCE plume.

- Collect water quality data from the Hempstead Village supply wells and analyze it for PCE and TCE.

- Should the Garden City supply wells go offline for an extended period of time, model simulations indicate that a contingency extraction well located immediately upgradient and continuously pumping at least 500 gpm should be sufficient to capture most of the PCE/TCE plume.

Table 5 includes a summary of the monitoring and pump and treat alternatives with regard to PCE.

As mentioned throughout this memorandum, the model simulations were developed under very specific assumptions and are subject to change with different pumping rates, well screen intervals, plume extent and concentrations, and aquifer transport parameters. For final design, the model should be updated as described below and additional simulations should be conducted.

- The model calibration period should be extended so that simulated heads can be compared to measurements at the site multi-port wells installed in 2006 and the model calibration can be refined accordingly.

- A pumping test should be conducted to confirm or modify aquifer hydraulic properties assigned in the model and quantify the influence of the Garden City supply wells on head at all site monitoring locations (including multi-port wells). The results of the pumping test should be incorporated into the model and additional simulations should be run to verify the capture of the TCE and PCE plume.

- All available boring logs should be collected from NYSDEC and compared to model stratigraphy. The model should be updated accordingly.

- Additional sensitivity simulations should be made focusing on parameters that are difficult to determine with certainty, such as effective porosity.

Table 5
Summary of Alternatives for PCE

Alternative	Plume Clean-up Time (Years)			# of Years for < 5 ppb at Supply Wells 10 & 11			# of Years for < 1 ppb at Supply wells 10 & 11		
	n_e			n_e			n_e		
	0.10	0.15	0.20	0.10	0.15	0.20	0.10	0.15	0.20
Monitoring	30	46	61	7	9	12	9	15	18
Pump and Treat	25	35	51	4	5	7	7	10	15

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Appendix B

Appendix B
Draft Cost Estimate for Remedial Action Alternatives

Alternative 2: Monitoring - Cost Estimate Summary
Old Roosevelt Field Contaminated Groundwater Site

Item No.	Item Description	Extended Cost
CAPITAL COSTS		
1.	Long-term Monitoring Program Planning	$ 69,120
2.	Baseline Groundwater Sampling	$ 151,000
3.	Soil Vapor Sampling	$ 84,114
	TOTAL CAPITAL COSTS	**$ 304,234**
OPERATION & MAINTENANCE (O&M) COSTS		
Annual O&M Costs		
4.	Long-term Monitoring (Annual GW Sampling 1-25) [2]	$ 151,000
5.	Long-term Monitoring (Annual GW Sampling 26-46)	$ 111,000
PRESENT WORTH OF 46 YEAR COSTS (with discounting)		
6.	Total Capital Costs	$ 304,234
7.	Long-term Monitoring Cost (46 years)	$ 1,981,238
	TOTAL PRESENT WORTH OF 46 YEAR COSTS (w/ discounting)	**$ 2,290,000**

Notes:

1. Present worth calculation assumes no inflation
2. Based on results from the preliminary groundwater model, contaminant concentrations in the plume would decrease significantly in 25 years. Therefore, in this FS, the long-term monitoring program will be reduced from year 25 to year 46.

Job No. 3223
Project Old Roosevelt Field Final FS
Subject Alternative 2 - Cost Backup

Prepared by: G.C.
Checked by: TM

No. 1 Long-term Monitoring Program Planning

Work Plan/HASP/CQCP Preparation	360	hr	×	$120	=	$	43,200
Site Mangement Plan development	120	hr	×	$120	=	$	14,400
Subtotal						**$**	**57,600**
Contingency (20%)						**$**	**11,520**
TOTAL						**$**	**69,120**

No. 2 Baseline Groundwater Sampling

Assume the cost for baseline groundwater sampling be the same as annual long-term monitoring

No. 3 Soil Vapor Sampling

Assume 60 samples from commercial buildings and 25 samples from residential buildings

Assume 5 persons 2 days to collect samples from commercial buildings; 2 persons 2 days to collect samples from residential buildings, one day is 12 hours

Sampling preparation	20	hr	×	$120	=	$	2,400
Mobilization	40	hr	×	$120	=	$	4,800
Sampling labor	136	hr	×	$120	=	$	16,320
Data tabulation	43	hr	×	$120	=	$	5,160
Data validation	43	hr	×	$130	=	$	5,590
Vapor intrusion report	60	hr	×	$120	=	$	7,200
subtotal						$	41,470
Soil Vapor Analysis							
Commercial building samples at $300 per sample	60	ea	×	$300	=	$	18,000
Residential building samples at $425 per sample	25	ea	×	$425	=	$	10,625
						$	28,625
Subtotal						**$**	**70,095**
Contingency (20%)						**$**	**14,019**
TOTAL						**$**	**84,114**

No.4 Long-term monitoring (Annual groundwater sampling Year 1 to 25)

Assume groundwater samples will be collected from 7 existing multiport monitoring wells, two regular monitoring wells, and two supply wells

A Sampling Project Planning (e.g., Staffing, Lab Procurement, Obtaining Equipment)

Assume annual monitoring on long-term basis

Project manager	16	hr	×	$150	=	$	2,400
Environmental engineer	40	hr	×	$120	=	$	4,800
Procurement specialist	40	hr	×	$90	=	$	3,600
Total per sampling event:						**$**	**10,800**

B Field Sampling Labor

Assume 2 person for 1 day x 10 hour days @ $120 per hour to mob and demob
Assume 3 persons for 8 days x 12 hour days @ $120 per hour to sample
Assume 1 multiport wells or 4 wells per day for sampling (7 multiport & 4 wells)

Mob/demob	20	hr	×	$120	=	$	2,400
Well Sampling	288	hr	×	$120	=	$	34,560
Total per sampling event:						**$**	**36,960**

C Travel Expense and per Diem

Assume van and car rental at $85/day
Assume one van for 9 days, and two cars for 9 days
Per diem rate at $250/day (lodging plus meal)

Van and car rental	27	day	×	$85	=	$	2,295
Per diem	25	day	×	$250	=	$	6,250
Toll	27	day	×	$30	=	$	810
Total per sampling event:						**$**	**9,355**

D Sampling Equipment, Shipping, Consumable Supplies

Assume miscellaneous materials @ $100 per day

Equipment & PPE	1	ea	×	$5,000	=	$	5,000
Shipping	8	day	×	$200	=	$	1,600
Misc	8	day	×	$100	=	$	800
Total per sampling event:						**$**	**7,400**

E Annual Sampling Analysis and Data Validation

LDL VOCs

85	samples	
5	field duplicate	(one per 20)
8	Field Blank	(one per day)
8	Trip Blanks	(one per day)
106	**Total Samples Per Sampling Event**	

Assume $150/sample for LDL VOCs

Assume samples validated @ 1 hrs per sample

Total Analytical Cost:	106 ea	×	$150		$	15,900
Samples management/validation	106 hr	×	$120	=	$	12,720
Total Analysis & Validation per sampling event:					**$**	**28,620**

F Data Evaluation & Reporting (Annual Monitoring)

Project manager	24 hr	×	$150	=	$	3,600
Environmental engineer	120 hr	×	$120	=	$	14,400
Environmental scientist	120 hr	×	$120	=	$	14,400
Total Data Evaluation & Reporting:					**$**	**32,400**

Subtotal of annual groundwater sampling cost	**$**	**125,535**
Contingency (20%)	$	25,107
TOTAL ANNUAL GROUNDWATER SAMPLING COST	$	151,000

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Checked by: TM

No.5 Reduced Long-term monitoring (Annual Cost Year 26 to 46)

Assume groundwater samples will be collected from four multiport monitoring wells, two regular monitoring wells and two supply wells

A Sampling Project Planning (e.g., Staffing, Lab Procurement, Obtaining Equipment)

Assume annual monitoring on long-term basis

Project manager	16	hr	×	$150	=	$	2,400
Environmental engineer	40	hr	×	$120	=	$	4,800
Procurement specialist	40	hr	×	$90	=	$	3,600
Total per sampling event:						**$**	**10,800**

B Field Sampling Labor

Assume 2 person for 1 day x 10 hour days @ $120 per hour to mob and demob
Assume 3 persons for 5 days x 12 hour days @ $120 per hour to sample all the wells

Mob/demob	20	hr	×	$120	=	$	2,400
Well Sampling	180	hr	×	$120	=	$	21,600
Total per sampling event:						**$**	**24,000**

C Travel Expense and per Diem

Assume van and car rental at $85/day
Assume one van for 6 days and two cars for 6 days
Per diem rate at $250/day (lodging plus meal)

Van and car rental	18	day	×	$85	=	$	1,530
Per diem	10	day	×	$250	=	$	2,500
Toll	18	day	×	$30	=	$	540
Total per sampling event:						**$**	**4,570**

D Sampling Equipment, Shipping, Consumable Supplies

Assume miscellaneous materials @ $100 per day

Equipment & PPE	1	ea	×	$5,000	=	$	5,000
Shipping	5	day	×	$200	=	$	1,000
Misc	5	day	×	$100	=	$	500
Total per sampling event:						**$**	**6,500**

E Annual Sampling Analysis and Data Validation

LDL VOCs		
40	samples	
2	field duplicate	(one per 20)
5	Field Blank	(one per day)
5	Trip Blanks	(one per day)
52	**Total Samples Per Sampling Event**	

Assume $150/sample for LDL VOCs

Total Analytical Cost:	52	ea	×	$150		$	7,800

Assume samples validated @ 1 hrs per sample

Samples management/validation	52	hr	×	$120	=	$	6,240
Total Analysis & Validation per sampling event:						**$**	**14,040**

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Subject Alternative 2 - Cost Backup

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F	**Data Evaluation & Reporting (Annual Monitoring)**						
	Project manager	24 hr	×	$150	=	$	3,600
	Environmental engineer	120 hr	×	$120	=	$	14,400
	Environmental scientist	120 hr	×	$120	=	$	14,400
	Total Data Evaluation & Reporting:					**$**	**32,400**
	Subtotal of annual groundwater sampling cost					**$**	**92,310**
	Contingency (20%)					$	18,462
	TOTAL ANNUAL GROUNDWATER SAMPLING COST					**$**	**111,000**

Job No. 3223
Project Old Roosevelt Field Final FS
Subject Alternative 2 - Cost Backup

Prepared by: G.C.
Checked by: TM

PRESENT WORTH CALCULATIONS

Assume discount rate is 7%:

For annual monitoring costs

This is a recurring cost every year for n years.

This is a problem of the form find (P given A, i, n) or (P/A,i,n)

P = Present Worth

A= Annual amount

i = interest rate

No. 8 For long-term monitoring (1-25 years)

The interest rate tables for i = 7% and n = 25 years

The multiplier is	**11.6536**

For long-term monitoring (26-46 years)

(P/F,7%,25)*(P/A,7%,21)

P/F, 7%, 25 =	0.1842
P/A, 7%, 21 =	10.8355
The multiplier is	**2.00**

Alternative 3: Pump-and-Treat - Cost Estimate Summary
Old Roosevelt Field Contaminated Groundwater Site

Item No.	Item Description	Extended Cost	
CAPITAL COSTS			
1.	Predesign Investigation	$	1,110,440
2.	Work Plan for Long-term Monitoring Program and SMP	$	69,120
3.	Baseline groundwater sampling	$	174,756
4.	Groundwater Modeling	$	72,000
5.	Engineering Design	$	725,000
6.	Groundwater Pump and Treat System Construction	$	3,203,963
7.	Evaluation and Replacemednt of the Air Strippers	$	799,700
8.	Soil Vapor Sampling	$	84,114
	TOTAL CAPITAL COSTS	**$**	**6,239,000**
OPERATION & MAINTENANCE (O&M) COSTS			
Annual O&M Costs			
9.	Groundwater (GW) Treatment Plant O&M	$	675,152
10.	Long-term Monitoring (Annual GW Sampling)(1-25 years)	$	174,756
11.	Reduced Long-term Monitoring (Annual GW Sampling)(25-35 years)	$	111,000
PRESENT WORTH OF 35 YEAR COSTS (with discounting)			
12.	Total Capital Costs	$	6,239,000
13.	Pump-and-treat O&M Costs for 10 years	$	4,741,998
14.	Long-term Monitoring Cost (for 35 years)	$	2,180,142
	TOTAL PRESENT WORTH OF 37 YEAR COSTS	**$**	**13,160,000**

Notes:

1. Present worth calculation assumes no inflation.
2. The pump and treat system downgradient from SVP-4 will operate 10 years
3. It will take 35 years for contaminants concentrations in the plume to be reduced below 5 ppb. However, because the size of the plume would be significantly reduced after 25 years, the scale of long-term monitoring will be reduced after 25 years.

Job No. 3223
Project Old Roosevelt Field Final FS
Subject Alternative 3 - Cost Backup

Prepared by: G.C.
Checked by: TM

No.1	**Predesign Investigation**								
	Work Plan	200	hr	×	$120	=	$	24,000
	QAPP/HASP	300	hr	×	$120	=	$	36,000
	Installation of four multiport wells	3	LS	×	$275,000	=	$	825,000
	Literature review for historical lithology logs	80	hr	×	$120	=	$	9,600
	Infiltration test at the recharge basin	1	LS	×	$15,000	=	$	15,000
	Pumping test at supply wells	1	LS	×	$20,000	=	$	20,000
	Pre-design investigation report	300	hr	×	$120	=	$	36,000
	Subtotal						**$**	**965,600**
	Contingency (15%)						$	144,840
	TOTAL						**$**	**1,110,440**
No. 2	**Workplan for Long-term Monitoring Program and SMP**							
	see Alternative 2 for details							
No. 4	**Groundwater Modeling**	600	hr	×	$120	=	**$**	**72,000**
No. 5	**Engineering Design**							
	Assume design of pump and treat systems for upgradient location							
	Project management and meetings	1	LS	×	$120,000	=	$	120,000
	Site visits	1	LS	×	$15,000	=	$	15,000
	Prepare for draft submittal	1	LS	×	$300,000	=	$	300,000
	Prepare for draft cost estimate	1	LS	×	$40,000	=	$	40,000
	Value engineering	1	LS	×	$20,000	=	$	20,000
	Prepare for final submittal	1	LS	×	$200,000	=	$	200,000
	Prepare for final cost estimate	1	LS	×	$30,000	=	$	30,000
	Total for engineering design						**$**	**725,000**
No. 6	**Pump and treat system construction (for SVP-4E)**							
	Mob/demob	1	LS	×	$20,000	=	$	20,000
	Survey	1	LS	×	$25,000	=	$	25,000
	A. Extraction Well Installation						$	246,203
	B. Well Vault						$	4,499
	C. Treatment Building						$	332,968
	D. Treatment Components						$	616,356
	E. Earthwork						$	159,413
	F. System Startup						$	217,000
	Subtotal						**$**	**1,621,439**
	Permit and Legal issues	2	% of construction cost				$	32,429
	Detailed design	15	% of construction cost				$	243,216
	Project management	15	% of construction cost				$	243,216
	Office and field support	5	% of construction cost				$	81,072
	Subcontract procurement	5	% of construction cost				$	81,072
	Profit	10	% of construction cost				$	162,144
	Total PM/construction supervision						**$**	**843,148**

	Subtotal for construction					$	2,464,587
	Engineering Support during construction (15%)					$	369,688
	Contingency (15%)					$	369,688
	TOTAL PUMP AND TREAT CONSTRUCTION COST					**$**	**3,203,963**
No. 7	**Evaluation and Replacement of Air Strippers**						
	Site Visit (assume four persons)	32 hr	×	$120	=	$	3,840
	Travel costs	1 LS	×	$500	=	$	500
	Evaluation Report and meeting	100 hr	×	$120	=	$	12,000
	Total Cost for the Evaluation					**$**	**16,340**
	Replacement of Two Packed Tower Air Strippers						
	Assume the two air strippers will be packed tower type, 28 feet tall and 8 feet in diameter						
	Assume the air strippers package includes system control panels, pumps, and blowers						
	Assume the start up of the system will take 4 weeks						
	Air-stripper with electrical control panel	2 LS	×	$203,600	=	$	407,200
	Shipping and handling	1 LS	×	$10,000	=	$	10,000
	Removal of old and Installation of new	2 LS	×	$101,800	=	$	203,600
	Start up						
	One Project Manager, 8 hours per week	32 hr	×	$150	=	$	4,800
	One Engineer, 40 hours per week	160 hr	×	$90	=	$	14,400
	One Technician, 40 hours per week	160 hr	×	$80	=	$	12,800
	Subtotal Cost for Replacement of Air Strippers					$	652,800
	Contingency (20%)					$	130,560
	Total Cost for Replacement of Air Strippers					**$**	**783,360**

No. 8 Soil Vapor Sampling

See Alternative 2 under soil vapor sampling

No. 11 Reduced Long-term Monitoring Program

See Alternative 2 under reduced long-term monitoring

No. 6 Pump and Treat System Construction

A. EXTRACTION WELL INSTALLATION

Assume one extraction well 365 feet bgs, screen 100 feet

Test soil boring 11-inch Hollow stem auger borehole drilling	400	ft	×	$65	=	$	25,840
Well - 11-inch Hollow stem auger borehole drilling (RS Means 2005 ECHOS 33 23 1104)	400	ft	×	$65	=	$	25,840
8-inch stainless steel screen (RS Means 2005 ECHOS 33 23 0226)	100	ft	×	$382	=	$	38,196
8-inch stainless steel casing (RS Means 2005 ECHOS 33 23 0126)	300	ft	×	$420	=	$	125,877
Well completion materials	300	ft	×	$12	=	$	3,600
Well development	80	hr	×	$150	=	$	12,000
Decon pad	1	LS	×	$750	=	$	750
Decon of equipment	3	hr	×	$200	=	$	600
Roll-off for soil cuttings (Assume one 20 C.Y. rental and handling)	1	EA	×	$1,200	=	$	1,200
Baker Tank for development water (rental and handling)	1	EA	×	$1,300	=	$	1,300
Soil and water disposal	1	LS	x	$6,000		$	6,000
Well design	1	LS	x	$5,000		$	5,000
TOTAL EXTRACTION WELL INSTALLATION COST						$	246,203

B. WELL VAULTS

Well Vault (RS Means 2005ECHOS 33 23 2205)	1	EA	×	$4,499	=	$	4,499
TOTAL WELL VAULT COST						$	4,499

C. TREATMENT BUILDING

Assume a building 40 ft wide and 40 ft long

Concrete & Soil Testing	1	LS	×	$5,000	=	$	5,000
Excavation (assume 2 feet) (RSMeans 31 23 16.16.6035)	119	CY	×	$15.60	=	$	5,001
Structure fill	119	CY	×	$25	=	$	2,963
Concrete foundation (RSMeans 031113.40.0020)	1,600	SF	×	$13.29	=	$	21,264
Pre-engineered steel building	1	LS	×	$150,000	=	$	150,000
Building set up (including installation, painting etc.)	1	LS	×	$50,000	=	$	50,000
Fence and gate (RS Means 323113.20.0200)	500	ft	×	$17.48	=	$	8,740
Pavement restoration	1	LS	×	$50,000	=	$	50,000
Landscaping	1	LS	×	$20,000	=	$	20,000
Site Grading	1	LS	×	$20,000	=	$	20,000
TOTAL TREATMENT BUILDING COST						$	332,968

D. TREATMENT COMPONENTS

Extraction Pump (RS Means ECHOS 33 23 0565)	1	EA	x	$10,579	=	$	10,579
Low profile air stripper	1	EA	x	$36,718	=	$	36,718
Piping, fitting and support within building	500	ft	x	$40	=	$	20,000
Valves	50	EA	x	$300	=	$	15,000
I&C	1	LS	x	$200,000	=	$	200,000
HVAC	1	LS	x	$30,000	=	$	30,000
Light	1	LS	x	$10,000	=	$	10,000
Electrical power supplies, wiring, cable	1	LS	x	$150,000	=	$	150,000
				Subtotal equipment cost		$	472,297
shipping and handling *(assume 20% of equipment cost)*						$	94,459
Installation *(assume two months)*							
technician	320	hr	×	$45	=	$	14,400
labor	320	hr	×	$35	=	$	11,200
supervisor	320	hr	×	$75	=	$	24,000
subtotal						$	49,600
TOTAL TREATMENT COMPONENTS COST						$	616,356

F. System Startup

Startup of the system (Initial Testing Period, assume one months)

Pump testing of the extraction well	1	LS	x	$100,000	=	$	100,000
Startup of the treatment system - service by vendor	1	LS	x	$75,000	=	$	75,000
One project manager, 12 hr per week	60	hr	x	$150	=	$	9,000
One engineer, 40 hr per week	200	hr	x	$90	=	$	18,000
One technician, 5 days a week	200	hr	x	$75	=	$	15,000
TOTAL STARTUP COST						$	217,000

E. EARTHWORK

Trench - Excavation and Fill

Assume 5 ft deep, 2 ft wide, and 600 ft long trench to the treatment facility	222 CY				
Assume 5 ft deep, 2 ft wide, and 1,000 ft long trench to the recharge basin	370 CY				
Assume all excavated soil will be backfilled to the trench					
Assume 6-inch of crushed stone around the pipe as utility bedding					
Utility bedding, crushed stone 3/4" to 1/2" (RSMeans 31 23 23.16.0100)	89 CY	×	$35.20	=	$3,129
Labor					
One Laborer	20 day	×	$358.00	=	$7,160
One Backhoe loader 80HP operator	20 day	×	$462.80	=	$9,256
One Dozer 200HP operator	20 day	×	$462.80	=	$9,256
Equipment					
Backhoe loader 80 HP	20 day	×	$313.94	=	$6,279
Dozer 200HP	20 day	×	$1,087.24	=	$21,745
Vibratory Roller, Towed, 23 ton	3 day	×	$1,088.24	=	$3,265
Vibrating plate, gas, 18"	3 day	×	$32.12	=	$96
Piping					
Assume 4-inch 600 ft pipe to the treatment facility					
Assume 6-inch 1,000 ft pipe to the recharge basin					
4-inch HDPE piping (RSMeans 22 11 13.44.0650)	600 ft	×	$20.90	=	$12,540
6-inch PVC pressure piping (RSMeans 22 11 13.74.4490)	1,000 ft	×	$9.46	=	$9,460
pipe fittings (25% of pipe material)					$5,500
Piping installation labor (2-man crew)	43 day	×	$970.40	=	$41,727
Restoration of asphalt and grass					
Pavement and grass restoration over trenched area	1 LS	×	$20,000	=	$20,000
Erosion control during construction	1 LS	×	$10,000	=	$10,000
TOTAL EARTWORK COST					**$159,413**

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Project Old Roosevelt Field Final FS
Subject Alternative 3 - Cost Backup

Prepared by: G.C.
Checked by: TM

No. 9 ANNUAL GROUNDWATER TREATMENT PLANT O&M COST

A. Labor Cost:

Assume one operator at 16 hours/week

Technician, 40 hours per week	2,080	hr	×	$80	=	$	166,400
Project Management, 16 hours per month	192	hr	×	$150	=	$	28,800
Monthly Report, 32 hours per month	384	hr	×	$90	=	$	34,560
Total Annual Labor Cost					=	**$**	**229,760**

B. Analysis Cost:

Assume influent, treated groundwater and off-gas will be sampled once a week.
Water samples at $400/sample, gas samples at $300/sample
Water samples will be analyzed for VOCs, metals, and wet chemistry (TSS, TDS, Alkalinity, pH)

Water samples analyzed	104	EA	×	$400	=	$	41,600
Samples analyzed	52	EA	×	$300	=	$	15,600
Total Annual Cost for Sample Analysis					=	**$**	**57,200**

C. Power Cost:

Assume the groundwater extraction pump sending groundwater into the air stripper are 20 HP
Assume the blower is 10 HP, operation of pump and blower 24 hr/day
30 HP equals to 22.35 kilowatt (KW), power consumption 536.4 KW-hr/day
Assume light features and heating, cooling will be 10 KW, assume used 10 hours per day, 100 kw-hr/day

Daily cost of Power	636	kw-hr	×	$0.0630	=	$	40.09
Total power consumption per year					=	$	14,634
Demand charge	12	Mo	×	319.68	=	$	3,836
Service cost per year	1	LS	×	$400	=	$	400
Total Power Cost					=	**$**	**19,000**

D. Maintenance Cost:

Assume that the water does not have a significant amount of iron or biomass
Maintenance includes replace air filters, blower belts, and annual inspection of the whole treatment facility

Material	1	LS	×	$50,000	=	$	50,000
Service	1	LS	×	$40,000	=	$	40,000
Total Maintenance Cost					=	**$**	**90,000**
Subtotal of annual O&M cost						**$**	**395,960**
Contingency at 20%						$	79,192

E. Land leasing

Land leasing	**$**	**200,000**
TOTAL ANNUAL O&M COST	**$**	**675,152**

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No.10 Long-term monitoring (Annual groundwater sampling Year 1 to 25)

Assume groundwater samples will be collected from 10 multiport monitoring wells (each new multiport well has ten ports), two regular monitoring wells, and two supply wells

A Sampling Project Planning (e.g., Staffing, Lab Procurement, Obtaining Equipment)

Assume annual monitoring on long-term basis

Project manager	16 hr	×	$150	=	$	2,400
Environmental engineer	40 hr	×	$120	=	$	4,800
Procurement specialist	40 hr	×	$90	=	$	3,600
Total per sampling event:					**$**	**10,800**

B Field Sampling Labor

Assume 2 person for 1 day x 10 hour days @ $120 per hour to mob and demob
Assume 3 persons for 11 days x 12 hour days @ $120 per hour to sample
Assume 1 multiport wells or 4 wells per day for sampling (10 multiport & 4 wells)

Mob/demob	20 hr	×	$120	=	$	2,400
Well Sampling	396 hr	×	$120	=	$	47,520
Total per sampling event:					**$**	**49,920**

C Travel Expense and per Diem

Assume van and car rental at $85/day
Assume one van for 12 days and two cars for 12 days
Per diem rate at $250/day (lodging plus meal)

Van and car rental	36 day	×	$85	=	$	3,060
Per diem	35 day	×	$250	=	$	8,750
Toll	36 day	×	$30	=	$	1,080
Total per sampling event:					**$**	**12,890**

D Sampling Equipment, Shipping, Consumable Supplies

Assume miscellaneous materials @ $100 per day

Equipment & PPE	1 ea	×	$5,000	=	$	5,000
Shipping	11 day	×	$200	=	$	2,200
Misc	11 day	×	$100	=	$	1,100
Total per sampling event:					**$**	**8,300**

E Annual Sampling Analysis and Data Validation

LDL VOCs		
89	samples	
5	field duplicate	(one per 20)
11	Field Blank	(one per day)
11	Trip Blanks	(one per day)
116	**Total Samples Per Sampling Event**	

Assume $150/sample for LDL VOCs

Total Analytical Cost:	116 ea	×	$150	$	17,400

	Assume samples validated @ 1 hrs per sample							
	Samples management/validation	116	hr	×	$120	=	$	13,920
	Total Analysis & Validation per sampling event:						**$**	**31,320**
F	**Data Evaluation & Reporting (Annual Monitoring)**							
	Project manager	24	hr	×	$150	=	$	3,600
	Environmental engineer	120	hr	×	$120	=	$	14,400
	Environmental scientist	120	hr	×	$120	=	$	14,400
	Total Data Evaluation & Reporting:						**$**	**32,400**
	Subtotal of annual groundwater sampling cost						**$**	**145,630**
	Contingency (20%)						$	29,126
	TOTAL ANNUAL GROUNDWATER SAMPLING COST						**$**	**174,756**

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PRESENT WORTH CALCULATIONS

Assume discount rate is 7%:

This is a recurring cost every year for n years.

This is a problem of the form find (P given A, i, n) or (P/A,i,n)

P = Present Worth

A= Annual amount

i = interest rate

No. 13 Total Annual O&M Costs

The interest rate tables for i = 7% and n = 10 years

The multiplier for (P/A) =	**7.0236**

No. 14 Total Long-term Monitoring Costs

The interest rate tables for i = 7% and n = 25 years

The multiplier for (P/A) =	**11.6536**

(P/F,7%,25)*(P/A,7%,10)

P/F, 7%, 25 =	0.1842
P/A, 7%, 10 =	7.0236
The multiplier is	**1.29**

Contingency Plan - Cost Estimate Summary
Old Roosevelt Field Contaminated Groundwater Site

Item No.	Item Description	Extended Cost
CAPITAL COSTS		
1.	Groundwater Modeling	$ 48,000
2.	Engineering Design	$ 725,000
3.	Contingency Groundwater Pump and Treat System Construction	$ 4,889,240
	TOTAL CAPITAL COSTS	**$ 5,662,240**
OPERATION & MAINTENANCE (O&M) COSTS		
Annual O&M Costs		
4.	Contingency Groundwater (GW) Treatment Plant O&M	$ 675,152

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No. 3 Pump and treat construction

Mob/demob	1	LS	$20,000 =	$	20,000
Survey	1	LS	$25,000 =	$	25,000
A. Extraction Well and Injection wells Installation				$	764,149
B. Well Vault				$	13,497
C. Treatment Building				$	332,968
D. Treatment Components				$	539,283
E. Earthwork				$	401,640
F. System Startup				$	167,000
Subtotal				**$**	**2,263,537**
Permit and Legal issues	2	% of construction cost		$	45,271
Detailed design	15	% of construction cost		$	339,531
Project management	15	% of construction cost		$	339,531
Office support	10	% of construction cost		$	226,354
Subcontract procurement	8	% of construction cost		$	181,083
Profit	10	% of construction cost		$	226,354
Total PM/construction supervision				**$**	**1,358,122**
Subtotal for construction				$	3,621,659
Engineering Support during construction (15%)				$	543,249
Contingency (20%)				$	724,332
TOTAL PUMP AND TREAT CONSTRUCTION COST				**$**	**4,889,240**

A. EXTRACTION AND INJECTION WELLS INSTALLATION							
Assume one extraction well 410 feet bgs, screen 50 feet							
Soil boring 22-inch Air Rotary borehole drilling (RS Means 1998 ECHOS 33 23 1167, include 40% inflation)	410	ft	×	$396	=	$	162,266
12-inch stainless steel screen (RS Means 2005 ECHOS 33 23 0230, include 10% inflation)	50	ft	×	$480	=	$	24,011
12-inch stainless steel casing (RS Means 2005 ECHOS 33 23 0129, include 10% inflation)	360	ft	×	$582	=	$	209,535
Well completion materials	360	ft	×	$12	=	$	4,320
Well development	80	hr	×	$150	=	$	12,000
Well Design	1	LS	×	$5,000	=	$	5,000
Assume two injection wells 400 feet bgs, screen 100 feet							
Soil boring 10-inch Hollow stem auger borehole drilling (RS Means 2005 ECHOS 33 23 1104)	800	ft	×	$65	=	$	51,680
6-inch stainless steel screen (RS Means 2005 ECHOS 33 23 0124, include 10% inflation)	200	ft	×	$331	=	$	66,229
6-inch stainless steel casing (RS Means 2005 ECHOS 33 23 0124, include 10% inflation)	600	ft	×	$320	=	$	192,258
Well completion materials	600	ft	×	$12	=	$	7,200
Well development	80	hr	×	$150	=	$	12,000
Decon pad	1	LS	×	$750	=	$	750
Decon of equipment	12	hr	×	$200	=	$	2,400
Roll-off and drums for soil cuttings (Assume one 25 C.Y. roll-off))	1	EA	×	$1,200	=	$	1,200
Baker Tank for development water	1	EA	×	$1,300	=	$	1,300
Soil and water disposal	1	LS	x	$12,000		$	12,000
TOTAL EXTRACTION WELL INSTALLATION COST						**$**	**764,149**
B. WELL VAULTS							
Well Vault (RS Means 2005ECHOS 33 23 2205)	3	EA	×	$4,499	=	$	13,497
TOTAL WELL VAULT COST						**$**	**13,497**
C. TREATMENT BUILDING							
Assume a building 40 ft wide and 40 ft long							
Concrete & Soil Testing	1	LS	×	$5,000	=	$	5,000
Excavation (assume 2 feet) (RSMean 31 23 16.16.6035)	119	CY	×	$15.60	=	$	5,001
Structure fill	119	CY	×	$25	=	$	2,963
Concrete foundation (RSMeans 031113.40.0020)	1,600	SF	×	$13.29	=	$	21,264
Pre-engineered steel building	1	LS	×	$150,000	=	$	150,000
Building set up	1	LS	×	$50,000	=	$	50,000
Fence and gate (RS Means 323113.20.0200)	500	ft	×	$17.48	=	$	8,740
Driveway	1	LS	×	$50,000	=	$	50,000
Landscaping	1	LS	×	$20,000	=	$	20,000
Site Grading	1	LS	×	$20,000	=	$	20,000
TOTAL TREATMENT BUILDING COST						**$**	**332,968**
D. TREATMENT COMPONENTS							
Extraction Pump (RS Means ECHOS 33 23 0565)	1	EA	x	$42,680	=	$	42,680
Low profile air stripper	1	EA	x	$40,389	=	$	40,389
Piping, fitting and support within building	500	ft	x	$40	=	$	20,000
Valves	50	EA	x	$300	=	$	15,000
I&C	1	LS	x	$100,000	=	$	100,000
HVAC	1	LS	x	$30,000	=	$	30,000
Light	1	LS	x	$10,000	=	$	10,000
Electrical power supplies, wiring, cable	1	LS	x	$150,000	=	$	150,000
Subtotal equipment cost						$	408,069
Shipping and handling (20% of equipment cost)						$	81,614
System Installation							
technician	320	hr	x	$45	=	$	14,400
labor	320	hr	x	$35	=	$	11,200
supervisor	320	hr	x	$75	=	$	24,000
subtotal				Total labor cost		$	49,600
Total for Treatment Components						**$**	**539,283**
F. System Startup (Initial Testing Period, assume 5 weeks)							
Pump testing of the extraction well	1	LS	x	$75,000	=	$	75,000
Startup of the treatment system	1	LS	x	$50,000	=	$	50,000
One project manager, 12 hr per week	60	hr	x	$150	=	$	9,000
One engineer, 5 days per week	200	hr	x	$90	=	$	18,000
One technician, 5 days a week	200	hr	x	$75	=	$	15,000
				Total labor cost		**$**	**167,000**

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E. EARTHWORK

Trench - Excavation and Fill						
Assume 5 ft deep, 2 ft wide, and 2,500 ft long trench from injection well to the treatment facility	926 CY					
Assume 5 ft deep, 2 ft wide, and 2,100 ft long trench from injection well to the treatment facility	778 CY					
Assume 6 ft deep, 3 ft wide, and 200 ft long trench from extraction well to the treatment facility	133 CY					
Assume 5 ft deep, 2 ft wide, and 700 ft long trench to the recharge basin	259 CY					
Bedding material	311 CY		×	$35.20	=	$10,951
Labor						
Two Laborers	80 day		×	$358.00	=	$28,640
One Backhoe loader 80HP operator	40 day		×	$462.80	=	$18,512
One Dozer 200HP operator	40 day		×	$462.80	=	$18,512
Equipment						
Backhoe loader 80 HP	40 day		×	$313.94	=	$12,558
Dozer 200HP	40 day		×	$1,087.24	=	$43,490
Vibratory Roller, Towed, 23 ton	10 day		×	$1,088.24	=	$10,882
Vibrating plate, gas, 18"	10 day		×	$32.12	=	$321
Piping						
Assume 4-inch 2,500 ft pipe from injection well to the treatment facility						
Assume 4-inch 2,100 ft pipe from injection well to the treatment facility						
Assume 10-inch 200 ft pipe from extraction well to the treatment facility						
Assume 6-inch 700 ft pipe to the recharge basin						
4-inch HDPE piping (RSMeans 22 11 13.44.0650)	4600 ft		×	$20.90	=	$96,140
10-inch HDPE piping (RSMeans 22 11 13.44.1440)	200 ft		×	$113.30	=	$22,660
6-inch PVC pressure piping (RSMeans 22 11 13.74.4490)	700 ft		×	$9.46	=	$6,622
pipe fittings (25% of pipe material)						$25,691
Piping installation labor (two 2-man crews)	79 day		×	$970.40	=	$76,662
Restoration of asphalt and grass	1	LS		$20,000	=	$20,000
Erosion Control	1	LS		$10,000	=	$10,000
TOTAL EARTHWORK COST						**$401,640**

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Subject Contingency Plan - Cost Backup

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Checked by: TM

No. 4 ANNUAL GROUNDWATER TREATMENT PLANT O&M COST

A. **Labor Cost:**

Assume one operator at 8 hours/week

Technician, 16 hours per week	2,080	hr	×	$80	=	$	166,400
Project Management, 16 hours per month	192	hr	×	$150	=	$	28,800
Monthly Report, 32 hours per month	384	hr	×	$90	=	$	34,560
Total Labor						**$**	**229,760**

1 **Analysis Cost:**

Water samples will be analyzed for VOCs, metals, and wet chemistry (TSS, TDS, Alkalinity, pH)

Water samples analyzed	104	EA	×	$400	=	$	41,600
Samples analyzed	52	EA	×	$300	=	$	15,600
2 **Total Annual Cost for Sample Analysis**					=	$	57,200

C. **Power Cost:**

Assume the groundwater extraction pump sending groundwater into the air stripper are 20 HP

Assume the blower is 10 HP, operation of pump and blower 24 hr/day

30 HP equals to 22.35 kilowatt (KW), power consumption 536.4 KW-hr/day

Assume light features and heating, cooling will be 10 KW, assume used 10 hours per day, 100 kw-hr/day

Daily cost of Power	636	kw-hr	×	$0.0630	=	$	40.09
Total power consumption per year					=	$	14,634
Demand charge	12	Mo	×	$320	=	$	3,836
Service cost per year	1	LS	×	$400	=	$	400
Total Power Cost					=	**$**	**19,000**

D. **Maintenance Cost:**

Assume that the water does not have a significant amount of iron or biomass

Maintenance includes replace air filters, blower belts, and annual inspection of the whole treatment facility

Material	1	LS	×	$50,000	=	$	50,000
Service	1	LS	×	$40,000	=	$	40,000
Total Maintenance Cost					=	**$**	**90,000**

Subtotal of annual O&M cost	**$**	**395,960**
Contingency at 20%	$	79,192
E. **Land leasing**	**$**	**200,000**
TOTAL ANNUAL O&M COST	**$**	**675,152**